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THE NEW YORK RAPID TRANSIT ENTERPRISE has been approved by the commissioners appointed by the Supreme Court to pass upon its practicability. The commission, comprised of Messrs. Arthur D. Williams, John Sabine Smith and G. W. Young, review in their report all the objections brought against the enterprise, and dismiss them as unsubstantiated by the evidence. We quote from the report as follows:

Our own observation, no less than the testimony submitted herewith, has convinced us that no adequate solution of the rapid transit problem in this city below the Harlem is practicable except by an underground road. The criticisms generally made upon tunnels are not applicable to the tunnels contemplated in this plan. Experience in other cities, including our personal examination of the Boston Subway, has convinced us that, where the motive power involves no combustion, and where suitable light without combustion is provided, travel in tunnels can be made thoroughly wholesome and agreeable.

The Commission also presents estimates of the traffic, earnings and expenses of the completed road, and finds that the proposed road would be a paying enterprise, both to the city and to the contractor who shall build and operate it, and further that the city's financial condition is such as to permit it to undertake the work without danger of exceeding its limit of indebtedness.

TWO RAILWAY GRADE-CROSSING DECISIONS of far reaching importance have been handed down by the New Jersey Supreme Court during the past week. The first decision was in a suit by the Erie R. R. against the city of Newark, N. J., and was decided in favor of the railway. The city of Newark had opened a street across the tracks of the railway. The railway company was awarded in the lower courts the sum of $250 for the expense of planking and similar work in making the crossing. It asked to be allowed also for the expense of erecting and maintaining gates at the crossing, but the lower courts denied this claim. This last ruling has been overthrown by the Supreme Court, which holds that the taking of a railway's property for street purposes is an action entitling the road to damages, and compensation must include all moneys which the act causes the company to pay out, and the erection and maintenance of gates is an added expense for which the company is entitled to ask compensation. The decision is held by many lawyers to be so sweeping that every municipality desiring to open new streets across railway lines will not only have to pay for the right of way, but will be compelled to maintain gates and gatemen there in perpetuity. The decision, it is thought, will also tend to bring about the abolition of grade crossings, since it will be cheaper in the end to cross over or under the railway line than to maintain gates and gatemen.

The second decision is in a case between the Philadelphia & Reading R. R. and the township of Ewing, in Mercer county. The railway was convicted in the county courts of maintaining a nuisance in having no gates or flagman at a certain crossing. The Supreme Court reversed this decision, holding that a railway company is not obliged to take any greater precaution for the protection of crossings than is exacted by the statutes, the only exception being where a company had created a danger by its own act. The statutes make it necessary in most instances only to ring a bell or blow a whistle when approaching a crossing. This statute was enacted in 1852 and was amended after a vigorous fight in 1895, to the extent that the governing bodies of all municipalities in first-class counties are given the power to compel the protection of crossings.

OPPOSITION TO OVERHEAD WIRES for electric railways is disappearing in England. The borough engineer of Hastings, Mr. P. H. Palmer, after reviewing the experience of American, English and Continental cities with various systems of traction on street railways, concludes with the recommendation that the trolley system be adopted.

AN EXTENSION OF THE CAPE GOVERNMENT railways, in South Africa, from Mafeking north 587 miles to Buluwayo, has been completed and opened for traffic. This extension has been constructed in 18 months, the rate of progress being about one mile per day, although in some instances from 1½ to 2 miles of track were laid per day. This will be recognized as unusually rapid railway construction, especially when it is stated that the work was done entirely from one end and all material had to be transported from Cape Town to its site on the line. Very little heavy earthwork had to be done. The track is 3 ft. 6 ins. gage, with 60-lb. T-rails and steel ties, the latter being necessary, owing to the rapid destruction of wooden ties by the white ant. The steepest grade on the line is 1 in 80 and the sharpest curve is about 10°. The permanent way and structures have been designed for locomotives weighing from 70 to 80 tons. The cost of the line has been about $15,000 per mile, of which $9,000 per mile were for permanent way. Most of the rivers crossed are what are known as sand rivers, in whose beds no water is visible until digging down into the sand from 1 ft. to 6 ft. discloses it. In the first construction the line was carried across these sand rivers on embankment, but ultimately metal girder bridges on masonry piers and abutments will be built. Stone for masonry is found plentifully along the line, but the girders will be manufactured in England and shipped complete to their sites. Native labor was employed for the ordinary work and European for skilled work. Some of the native laborers would shift from 7 to 10 cu. yds. of ordinary soil per day, but the majority of them would handle only from 2 to 3 cu. yds. per day. The wages paid were about 75 cts. per day, with all food provided. The road opens up a farming and cattle raising country, and is also tributary to a large number of mines. The contractors for the extension were Pauling & Co.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Chesapeake & Ohio Ry., Nov. 4, about 5 miles east of Charlottesville, Va. The engine of the "F. F. V." vestibule express left the track while rounding a sharp curve and crashed into the side of a rock cut; cars were derailed and overturned, killing four persons, and injuring 17.

A LAKE STEAMER FOUNDERED in Lake Erie Nov. 6 during a gale, and, as far as is known, 19 men lost their lives. The vessel was the "Idaho," an old craft, loaded with general merchandise, bound from Buffalo to Chicago. The vessel sprung a leak which finally put out the fires and made the vessel unmanageable.

THE LEASE OF THE PHILADELPHIA GAS WORKS to the United Gas Improvement Co. is now assured, unless Mayor Warwick refuses to approve the ordinance just rushed through both branches of the city council, or unless the indignant public and the courts intervene with success. On Nov. 9, the ordinance passed the common council by a vote of 78 to 52, and on the succeeding day it passed a specially called session of the select council by a vote of 25 to 13. Immediately after the ordinance passed the latter body, application was made for an injunction to prevent the approval of the ordinance by the Mayor.

THE CHICAGO GARBAGE CONTRACT, noted last week as awarded to A. J. Murphy for five years, has been declared forfeited, owing to the failure of Mr. Murphy to file the necessary bonds. Various stories are being circulated regarding combinations among the other bidders, the awarding of the contract to the first or second next highest bidder and the probability of advertising for new bids. The several bidders and prices named by them were published in our Construction News Supplement for Sept. 9, 1897. The next highest bid was by Jas. Bradley & Co., $1,600,0000 for the five years, but it is said this cannot be accepted as it simply provides for dumping the garbage outside the city limts. The next highest bid was from Mulcare & Burke, $1,822,749, the garbage to be treated by the Holthaus reduction process.

A CONTRACTOR'S SUIT against the Chicago Drainage Board has been decided by the Federal court in favor of the contractors, and the board will have to pay from $50,000 to $90,000 (the exact amount to be determined later) and lose the $50,000 which it expected to recover from the plaintiff's bond on account of the failure to complete the contract. An appeal may be taken. The dispute was over the character of the material to be excavated in Section F, and the engineer had recommended that a settlement be made, as in the case of McArthur Bros., but the board decided to let the contractor bring suit. Ricker, Lee & Co. secured the contract at 23¾ cts. per cu. yd., but encountered a hard conglomerate which was hard to work. As the board refused to pay a higher price the contractors abandoned the work, after doing work valued at $195,000, and the section was completed by Gahan & Byrne, the board charging the cost against Ricker, Lee & Co. The latter firm sued the board for all money due, on the ground that the character of the material excavated had been different than the borings showed it to be. Judge Grosscup has rendered the following decision, reviewing the report of the Master in Chancery:

The information was on file in the engineer's office, and not using it in connection with the invitation to bidders was gross carelessness on some one's part at least. The contractor has been deceived and the law will not shield the board in the deception. The law demands that just treatment be given. The contractor did not waive his right by taking out some of the conglomerate. He showed instead a disposition to carry out his contract. Through the deception practiced the contractor has suffered a loss estimated at from $50,000 to $90,000, not counting the claim that the board would make on his bond for the completion of the work. The findings of the master are confirmed and exception to his report overruled.

INTERCEPTING SEWERS AT CHICAGO, to carry to the drainage canal the sewage now flowing into the lake, will have to be built by the city, though it had been hoped that this work would be participated in by the trustees of the Sanitary District, under the old plan by which it was proposed to build lateral canals. The trustees, however, consider that as soon as the river is broadened and deepened, in accordance with the present plans, there will be ample capacity for the minimum flow of 300,000 cu. ft. per minute, so that no lateral channels will be needed to supply water. The cost of rearranging the city's system of sewerage to discharge the sewage into the canal instead of the lake is estimated at $3,000,000.

THE KRUPP ARMOR PLATE PROCESS, according to a press dispatch from Pittsburg, is to be adopted by both the Carnegie Steel Co. and the Bethlehem Iron Co., they having purchased exclusive rights to the process in the United States. The details of the process have not been made public, but it is claimed that it is superior to the Harvey process, hardening the plates to a greater depth. "Notes on Naval Progress" for July, 1897, issued by the Navy Department, states that the English armor plate making firms of John Brown & Co., Cammell & Co., and Vickers, and the French firm St. Chamond, have also purchased rights under the Krupp process. The cost of armor under this process, it is stated, will probably be higher than under the Harvey process. If the Krupp process is superior to the Harvey and the Bethlehem and Carnegie companies have secured the exclusive rights under it in the United States, it would appear that they are in a position to offer a strong argument against the Government's building its own armor-plate plant.

A BULLET-PROOF ARMOR, invented by Mr. W. Lennard Foote, of Brooklyn, N. Y., was recently tested. It is stated, with satisfactory results. The character of the material is kept secret, but some of the claims made for it are: That it is 50% lighter than steel plates, having the same resisting qualities; it is non-magnetic, and can be placed around ship compasses where steel cannot; it will not corrode or scale; and when penetrated by bullets it does not splinter, and the bullet hole closes instantly, thus preventing the entrance of water. The test was made by shooting at a block of the material 2½ ins. thick, using a Krag-Jorgensen and a Winchester rifle. In a preliminary test, made to show the penetrating power of these rifles, shots were fired at a column of 24 ½-in. boards placed ½-in. apart. The bullets penetrated all but the two last boards. A shot fired at a ½-in. steel plate bent it badly, and a ¼-in. steel plate was penetrated. The tests shots failed to penetrate the special armor, and were found embedded in it, with the entering hole entirely closed. A plate of glass placed behind the armor was not shattered, showing the ability of the material to absorb vibrations. The shots were fired from a distance of 50 ft.

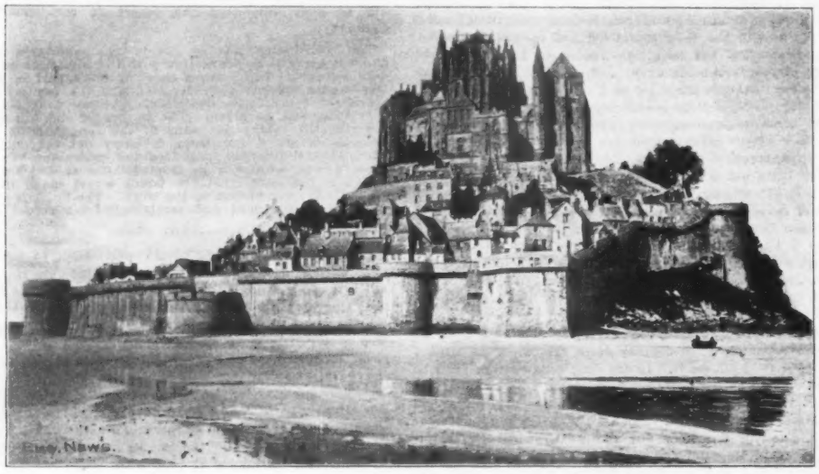
AN IMPORTANT DISCOVERY OF IRON ORE on the Menominee range is reported from Crystal Falls, Mich. It is on the bank of the Michigamme River, one mile south of Mansfield mine. The vein is stated to be 77 ft. deep and 40 ft. wide. The ore is of the Bessemer grade, analyzing 62% iron and 0.051 phosphorus.

AN ALUMINUM AIR-SHIP, fitted with a benzine motor, was tested at Berlin on Nov. 4. It is stated that this Schwarz air-ship rose to a height of 1,000 ft., and at first obeyed the steering gear and the one man lifted with it. But a strong wind rising later made the steering apparatus useless, and the ship descended after being in the air 12 minutes. The lifting power, if any other than wings, was not described.

THE FORTIFIED ABBEY OF MONT ST. MICHEL.

This remarkable monkish stronghold on the coast of Brittany is interesting to engineers from its structural features; and its impressive symmetry and harmony of mass make it one of the masterpieces of mediaeval architecture, though it is now shorn of its crowning spire. The views here reproduced were obtained by a member of the staff of this journal on a recent visit to Brittany.

About 1½ miles from the mainland, in the bay of St. Michel, a precipitous mass of granite rock



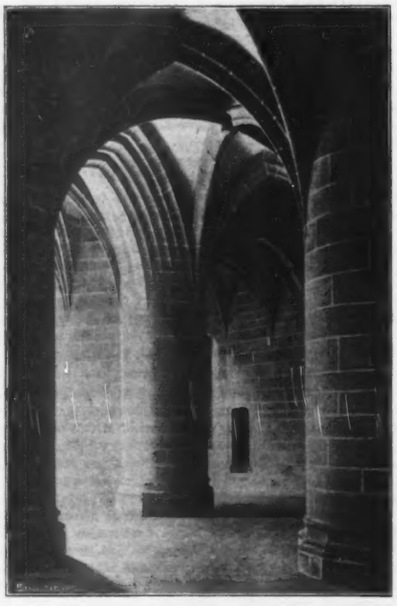
THE FORTIFIED ABBEY OF MONT ST. MICHEL ON THE COAST OF NORMANDY.

rises to a height above the sea of some 330 ft. Its circumference is some three-fifths of a mile in extent. This island, Mont St. Michel, was once in Breton territory, but the recent shifting to the south of the mouth of the River Couesnon makes it now geographically a part of Normandy. Within the last ten years a causeway has been built over the shifting sands that lie between the island and the mainland, and the once isolated character of this fortress-church has been destroyed.

According to tradition, the foundation of the Abbey of St. Michel dates from A. D. 709, in which year, we are told, the Archangel Michael appeared to St. Aubert, then bishop of Avranches, and commanded him to raise a temple in his honor upon this seabound rock. The difficulties of the task proposed made the good bishop hesitate, but the archangel enforced his commands by leaving the impress of his finger upon the bishop's skull; and in proof of this miracle the skull of St. Aubert is still preserved in the treasury of the Church of Saint Gervais, at Avranches, and it certainly shows a peculiar depression in the bony structure. Be this as it may, a chapel was founded upon the island rock early in the eighth century, and the miraculous fame of the shrine soon attracted hosts of pilgrims to the spot, and their pious alms laid the foundation of the fund from which the present wonderful and beautiful structure grew. The chapel was more than once destroyed and rebuilt in the Norman invasions of the ninth and tenth centuries; until, in 966, a successor of the fierce Rolla of Normandy established upon the rock a colony of Benedictine monks, who not only began to extend the buildings, but also to fortify their position upon this rugged island, and thus to protect the shrine against further sacrilegious assault.

The magnificent structure which now crowns Mont St. Michel was commenced in the year 1020, by Richard II., Duke of Normandy, and considerable parts of the original construction still remain. The task was indeed a difficult one; but the enormous walls, pillars and arches then erected to support the platform of the cruciform church still attest, in their remarkable state of perfection, to the skill of the monkish architects and the honesty and patience of the monkish masons. The church as now seen, minus its beautiful spire, was largely built in the twelfth and thirteenth centuries, though it was not completed until the fifteenth century. The mass is practically made up of three super-imposed stories built against the steep sides of the mountain, and joined to the church proper, to the residence of the Abbey, and to the towers and other more military features of the design. The walls supporting this mass, and sometimes starting at the sea-level, are stiffened by buttresses that stand unshaken after a period of more than six centuries.

On the first, or lower floor of the building, is the Almonry and the roomy cellars of the good monks; on the second floor is the Refectory, with its fireplace large enough to roast an ox whole, and the Hall of the Knights, here illustrated. Above these are the Dormitory and the Cloisters; the latter is a structure of wonderful beauty, with its lines of arches enclosing an open space used for collecting rain-water for the cisterns. Rising above and intricately connected with these divisions are the other structures noted. The only entrance to this fortified church is through an archway in a massive tower; and after this entrance is passed an exceedingly steep and long flight of steps must be surmounted to reach the inner gate and the guard-room. Taken in connection with its outer walls and towers, and the shifting nature of the sands surrounding the island, the natural and artificial defences of this sanctuary were so strong that the Knights of St. Michael and their monkish soldiers successfully repelled every attack made upon them through many generations of warfare. An interesting reminder of an English assault upon this stronghold, made in 1434, is still to be seen at the King's Gateway. There are two cannon abandoned by the English forces at the time. Each gun has a caliber of about 10 ins., and is made of wrought iron staves, continuously hooped with iron bands, and the breech is closed by a rough mass of wrought iron projecting some feet beyond the rear of the gun proper. Numerous iron rings attached to the length of the gun served to securely lash it in a massive wooden carriage; for trunnions were not then invented, and devices for lowering or raising the muzzle of the gun, independently of the carriage, were still unknown.



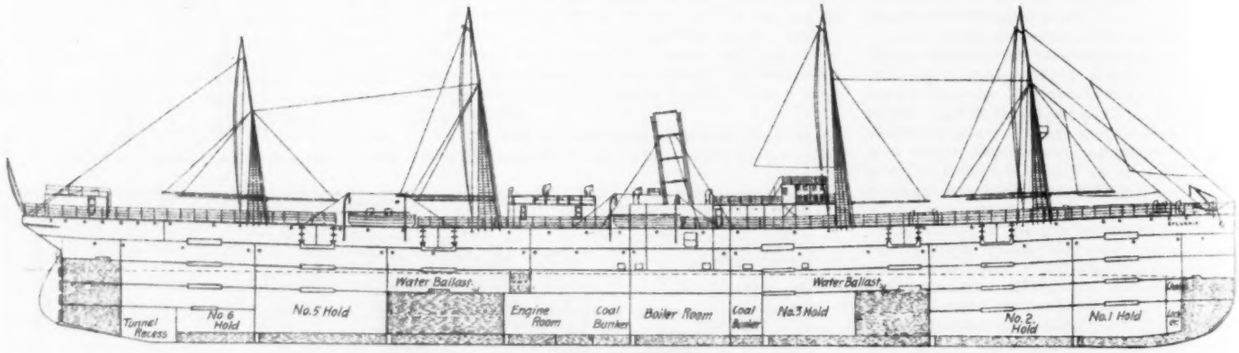
View in the Crypt, at Mont St. Michel; 15th Century Work.

The illustration showing the Hall of the Knights, built in the thirteenth century, will convey some faint idea of the impressive symmetry and beauty of design everywhere characteristic of this building. The decoration is very effective, yet exceedingly simple, as becomes the granite stone used in its erection; and the structural features of this hall seem all the more wonderful when it is realized that from the windows there is a sheer descent to the sea of almost 200 ft., and that the hall is supported for this height on buttressed walls of granite masonry. The view taken in the crypt shows some interesting fifteenth century work, also in granite. The feature of this crypt construction is the absence of capitals on the columns supporting the groined arches, and the lack of the usual terminal decoration where the molding of the arches meets the side walls. The increased intricacy of stone cutting, necessitated by this arrangement, is evident, while the general effect is pleasing and graceful. Throughout this whole building the engineer cannot help remarking the absence of settlement or other cracks and the excellent preservation of the masonry built six centuries ago. This "Wonder of the West" is a monument to the pious efforts of the people of old France, and to the wonderful skill of the architects of that day; but it is even more of a monument to the patience and honesty of the stone-cutters and masons who have preserved, so nearly intact, the designs of their masters.

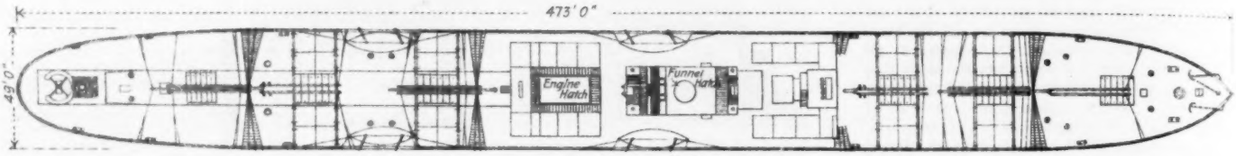
THE EDISON IRON-ORE CONCENTRATING WORKS AT THE OGDEN MINES, EDISON, N. J.

For the last six years Mr. Thomas A. Edison has been carrying on a series of experiments on a most gigantic scale in quarrying, crushing, concentrating and briquetting the lean magnetic iron ores of New Jersey. About $2,000,000 has been spent in the experiments, and in the construction and equipment of a complete plant with a capacity of treating about 300 tons of ore per hour, concentrating it from 20% to 68% of metallic iron. Of this amount of money, about three-quarters was contributed by Mr. Edison himself. He has also given the greater part of his time to the work, which has included the invention and design of methods of mining, conveying, crushing, etc., and the construction of machinery of the most ponderous character, in all of which his well-known boldness and originality are strikingly shown.

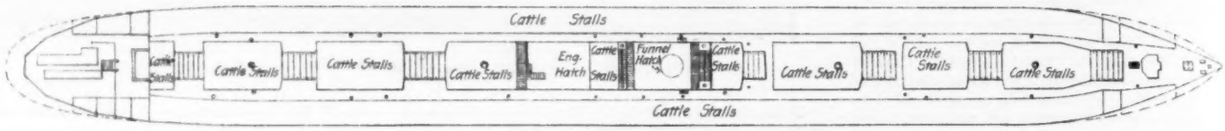
For more than a hundred years magnetic iron ore has been mined in New Jersey, the ore being found in pockets or lenses, of limited extent, dipping nearly vertically, and containing from 40 to 60% of metallic iron. Twenty years ago these ore bodies formed one of the chief sources of supply to the Eastern Pennsylvania furnaces, but in recent years the production has fallen off greatly, partly on account of the working out of the best mines, but more especially on account of the competition of the higher grade ores of Lake Superior, which latter has shifted the seat of greatest production of iron from Eastern to Western Pennsylvania, and caused the abandonment of many Eastern furnaces. Surrounding these bodies of high grade magnetic iron is a rock containing about 20% of metallic iron, which has hitherto been neglected by the miners, because it was too low in iron to be profitably used in the blast fur-



Longitudinal Section.

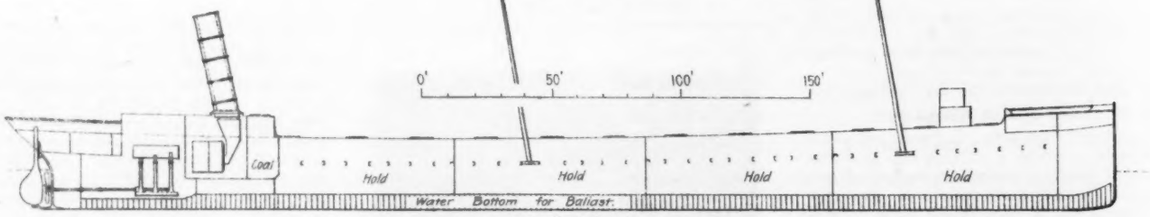


Plan of Shelter Deck.



Plan of Upper Deck.

OCEAN FREIGHT STEAMER.
BUILT BY THE LONDON & GLASGOW CO., 1895, FOR THE CUNARD CO.
(Capacity: 7,500 Tons on 27 ft. Draft.)



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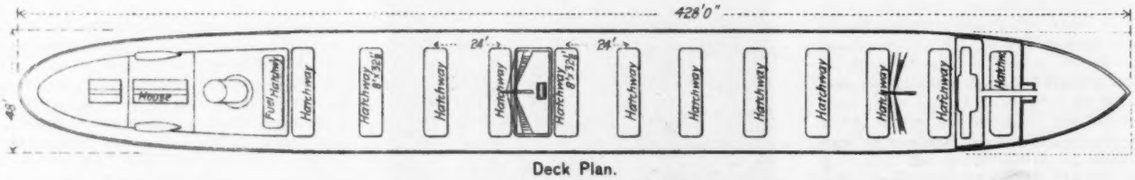
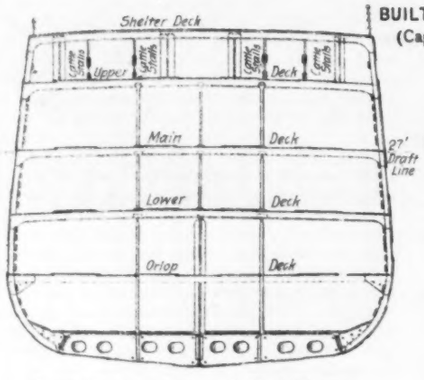


Deck Plan.

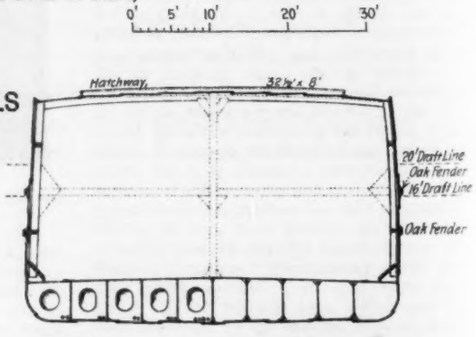
LAKE FREIGHT STEAMER.
BUILT BY F. W. WHEELER & CO., WEST BAY CITY, MICH., 1896.
(Capacity: 5,000 Tons on 16ft. Draft; 7,000 Tons on 20 ft. Draft.)



Cross Section of Ocean Freight Steamer.

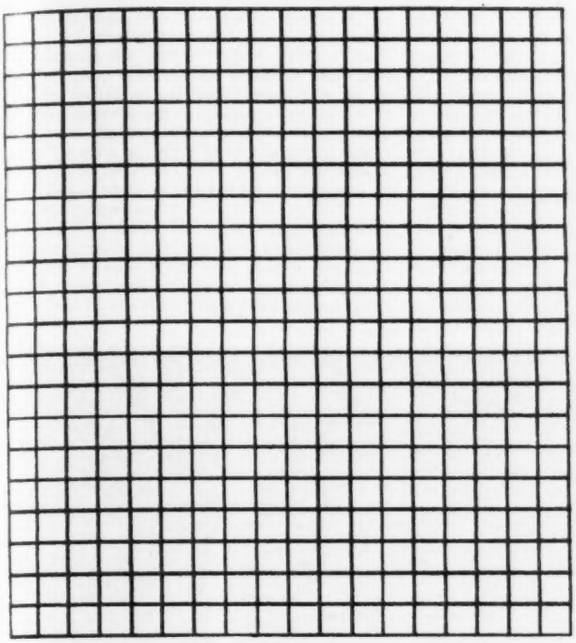
TYPICAL MODERN FREIGHT CARRYING VESSELS ON THE OCEAN AND THE GREAT LAKES.

(Accompanying Report of Major Thos. W. Symons, Corps of Engineers, U. S. A., upon a Proposed Great Lakes and Atlantic Ship Canal.)



Midship Section of Lake Freight Steamer.

CHAS. HART & SONS, LITH., 32 VESEY ST., N. Y.



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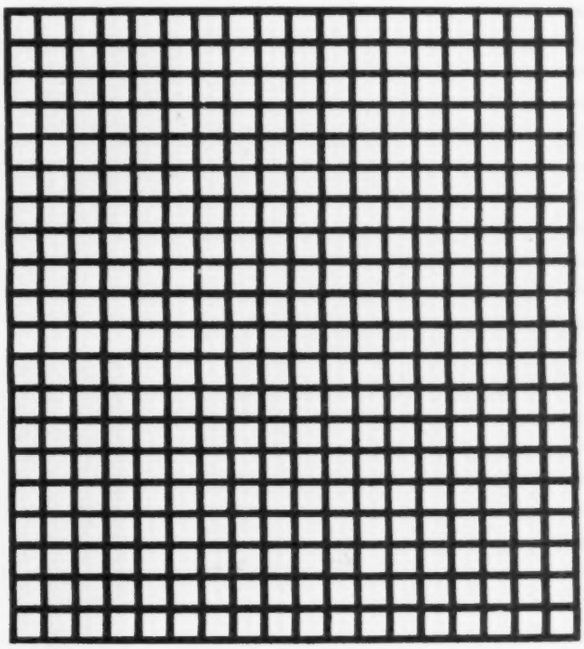

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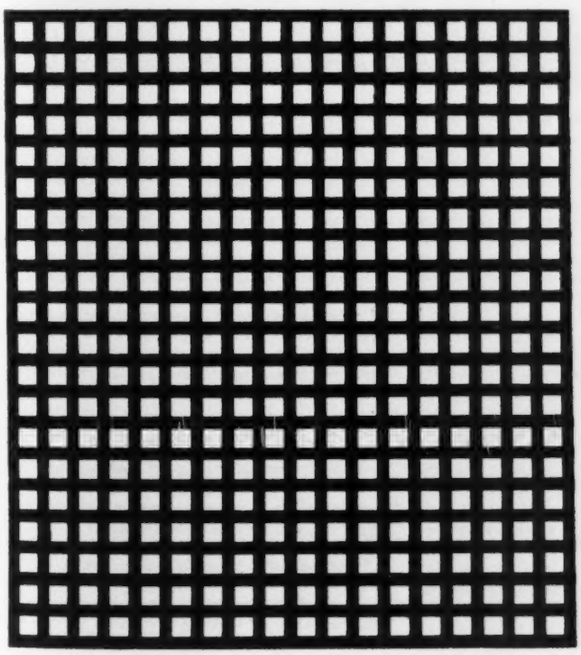

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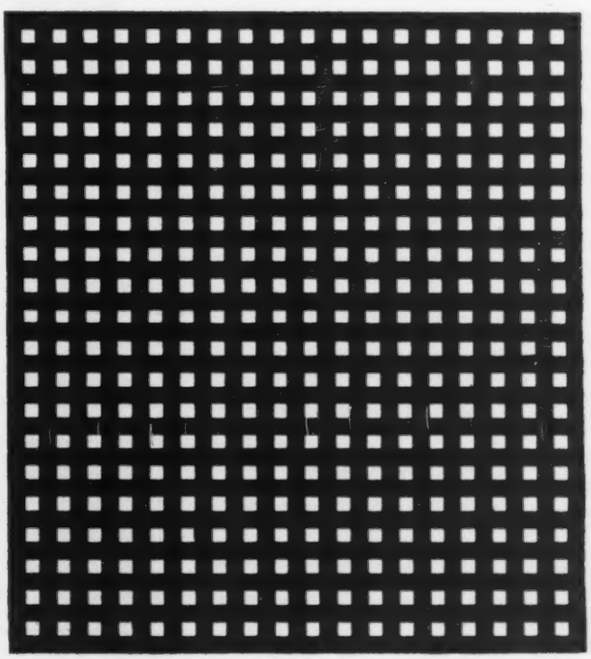


No. 4.

THE RINGELMANN SCALE FOR GRADING THE DENSITY OF SMOKE.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

nace. The quantity of this lean rock is practically limitless.

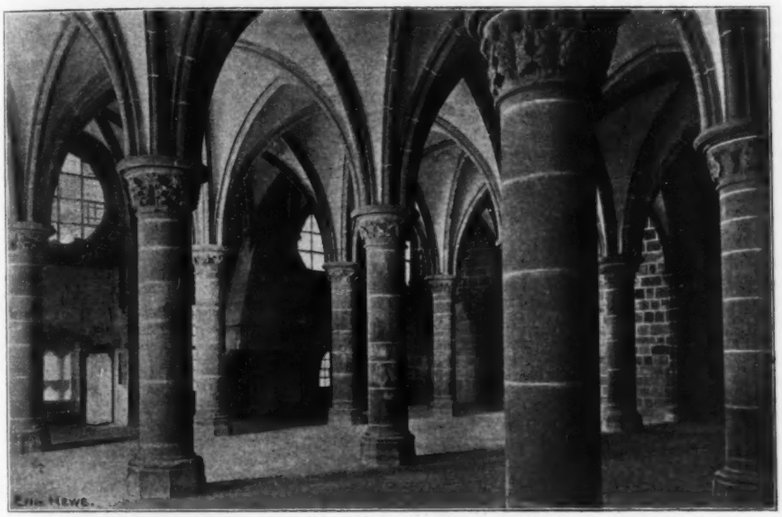
The problem which Mr. Edison has undertaken to solve is the vast one of quarrying this rock, crushing it fine, separating, by means of magnets, the particles of crystalline magnetic iron ore containing nearly 70% of iron from the particles of granitic rock with which the ore is intermingled, further separating from the ore by means of an air blast the particles of the mineral apatite, which contains the highly objectionable phosphorus, forming the crushed ore into solid briquettes by means of mixing it with a resinous binder and compressing it, loading it on cars and shipping it to Eastern Pennsylvania furnaces at a cost below that at which they can obtain Lake Superior or foreign ores, and which will enable them to live in spite of the severe competition of the Pittsburg furnaces.

The mere production of a briquette of rich iron ore from the lean rock involves no great difficulty, but to do it at such a low cost that it can compete with Lake Superior ores is a problem so stupendous that its solution requires an Edison, with all his genius as an inventor, his financial resources, and his courage. Six years ago its solution would not appear so difficult as it does today, for then the rich Mesaba ores were not scooped up with a steam shovel, loaded by machinery on a 6,000-ton Lake steamer, transported over Carnegie's new railroad in 100,000-lb. cars at the lowest freight rate ever known, and dumped without manual labor into furnaces capable of making over 700 tons of iron a day. The cheapening of the cost of iron by these means in the Pittsburg district has vastly increased the difficulty of the financial part of Mr. Edison's problem.

The details of Mr. Edison's methods and machinery have hitherto been withheld from publication, but he has recently allowed "The Iron Age" and "The Electrical Engineer" to obtain photographs and descriptions, from which both of these papers, in their issues of Oct. 28, have prepared elaborate illustrated articles. From these we glean a few particulars of the works, as follows:

The ore body worked at Edison, N. J., is about 11,000 ft. long and averages 600 ft. wide, containing, say, 200,000,000 tons. It is quarried by blasting by dynamite, 2-in. holes, 8 ft. apart, and 20 ft. deep, being drilled 12 ft. back from the working face. The ore, dislodged in blocks, some of which weigh as much as 5 tons, is loaded by a 93-ton steam shovel, built by the Vulcan Iron Works, of Toledo, into small cars or skips. These, when received in the crushing works, dump their contents onto a pair of "giant" rolls, 6 ft. diameter and 6 ft. face, set 7 ft. 3½ ins. centers, which are driven at a circumferential speed of 3,500 ft. per minute. The rolls have chilled plates bolted on them and rows of knobs, projecting 4 ins. from the plate. The rock is cracked by these rolls, and drops through them to another set of rolls, 4 ft. diameter, 5 ft. face, spaced 4 ft. 7½ ins. centers. The rock crushed by these rolls is elevated by a bucket conveyor and passed successively through two sets of rolls, each 36 ins. diameter, and a third set of 24 ins. diameter.

The ore, after being reduced by the series of crushing rolls to a size of ½ in. or less, is conveyed by an elevator to a dryer which consists of a tower 9 ft. square and 50 ft. high, fitted with a series of cast-iron plates placed one below the other at an angle of 45°, facing alternately one way and the other. The ore slides along these plates, falling from one to the other, and is dried by the heat from a fire at the bottom. The dried ore is then elevated to a stock-house which holds 16,000 tons. From this house a conveyor takes the ore to the concentrating house, in which it is first crushed by passing twice through a stand of 3-high rolls, and it is then passed through screens of 14-mesh, placed at an angle of 45°.



THE HALL OF THE KNIGHTS, AT MONT ST. MICHEL; 13TH CENTURY WORK.

The coarse material is taken back to the 3-high rolls and the fine is taken to the magnetic separators. These consist simply of a series of stationary magnets placed in a horizontal row, in front of which the ore is allowed to fall in a thin stream. The stream is thus divided into two, one, the concentrates, consisting of the particles rich in iron, which is diverted toward the magnets, while the other, the tailings, containing the sand, poor in iron, falls vertically. The concentrates from the first series of magnets, containing about 40% of iron, are taken to a dryer, then crushed in 3-high rolls, and passed through screens of 50-mesh, the coarse material passing over the screens being returned for regrinding. The fines are then taken to another series of magnets, which deliver concentrates of about 60% of iron. These concentrates are then subjected to an air blast which blows a fine dust from them, which process partially dephosphorizes the ore, since the dust is found to be richer in phosphorus than the original gangue of the ore. The dust is further treated by magnets, yielding a fine dust, which is sold for paint. The cleaned and dephosphorized concentrates, now containing 64% of iron, are then treated by still another series of magnets, making a final concentrate of 67 to 68% iron, and tailings of 35%, which are returned for regrinding and subsequent concentration.

The final concentrates are deposited in a couple of stock-houses, holding respectively 5,000 and 30,000 tons. From these houses the ore is taken to the briquetting house, in which it is first mixed with a resinous binding material in long cylindrical mixing machines, and formed into a coherent, pasty mass, which is then compressed by the briquetting machines into briquettes 3 ins. diameter by 1½ ins. thick, weighing about 19 oz. each. The briquettes fall from the machines into conveyor bands which take them slowly through drying ovens, where they are heated to about 600° F. They are thus made water-proof, hard, so as not to crumble during transportation or while passing through the upper part of the blast furnace, yet so porous as to be capable of absorbing 25% of their volume of alcohol, and, therefore, easily penetrable by the gases of the blast furnace.

The capacity of the plant is 300 tons of rock per hour, one-quarter of which is made into concentrates and the rest into crushed sand, which is valuable for building and other purposes. Running 20 hours a day the works can ship 1,500 tons of briquettes. Their composition is, iron 67 to 68%; silica, 2 to 3%; alumina, 0.4 to 0.8%; manganese, 0.05 to 0.10%; lime, magnesia and sulphur, traces; phosphorus, 0.028 to 0.033%; resinous binder, 0.75%; moisture, none; forming thus a blast furnace material of admirable quality. Tests made at the Crane furnace, Catasaqua, Pa., showed that the briquettes could be used without admixture of other ores, with an increase of product of iron and a decrease of the consumption of fuel and limestone as compared with the running on the usual ore mixture.

The works and machinery, in all their details, are a marvel of mechanical engineering. The whole of the work, from the mining of the rock to the loading of the briquettes on the cars, is accomplished with the remarkably small force of 125 men per shift. The material itself is handled entirely by machinery throughout every stage of the process.

The product of the plant at Edison is expected to be placed on the market at an early date, and should trials on the large scale prove that by its use the Eastern furnaces can make iron to compete with the Western furnaces using Lake Superior ores, a new lease of life and an enormous expansion of the Eastern iron industry is among the possibilities. Vast deposits of lean iron ores like those at Edison are to be found at many points in the Eastern states, from the Canada line to North Carolina.

The company operating the works at Edison is known as the New Jersey and Pennsylvania Concentrating Works; Thos. A. Edison, president; W. S. Mallory, vice-president; and J. F. Randolph, secretary and treasurer. The principal office is at Orange, N. J.

A SCALE FOR DETERMINING THE DENSITY OF SMOKE.

(With full-page plate.)

We are indebted to Mr. Bryan Donkin, of London, England, for a description of a system of determining the relative density or blackness of smoke which he has found useful in connection with tests of steam boilers and of smoke-preventing appliances, and for four printed cards which constitute the sole apparatus required for using the system, and which we have reproduced on our inset sheet. The system is the invention of Prof. Ringelmann, of Paris, and is said to have come into somewhat extensive use in Europe.

In making observations of the smoke proceeding from a chimney, the four cards, on which are printed a network of black lines, together with a card which is printed in solid black, and another left entirely white, are placed in a horizontal row and hung at a point about 50 ft. from the observer, and as nearly as convenient in line with the chimney whose smoke is to be observed. At this distance the lines become invisible, and the cards with printed lines appear to be of different shades of gray, ranging from very light gray to almost black. The observer glances from the smoke coming from the chimney to the cards, which are numbered from 0 to 5, determines which card most nearly corresponds with the color of the smoke, and makes a record accordingly, noting the time when the observation was made. Observations should be made continuously during, say, one minute, and the estimated average density during that minute recorded, and so on, records being made once every minute. The average of all the records made during a boiler test is taken

as the average figure for the smoke density during the test, and the whole of the record is plotted on cross-section paper in order to show in the form of a curve or broken line how the smoke varied in density from time to time.

A rule by which the cards may be reproduced by a skilful draftsman is given by Pros. Ringelmann, as follows:

Card 0, all white.

Card 1, black lines 1 mm. thick, 10 mm. apart between centers, leaving spaces 9 mm. square.

Card 2, lines 2.3 mm. thick; spaces 7.7 mm. sq.

Card 3, lines 3.7 mm. thick; spaces 6.3 mm. sq.

Card 4, lines 5.5 mm. thick; spaces 4.5 mm. sq.

Card 5, all black.

Mr. Donkin advises that the cards be made about 8 ins. square each, or four times as large in area as those he furnished us, and which are here reproduced.

It appears to us that this system of smoke grading may serve a very useful purpose. City ordinances are already in force in many places forbidding the emission of "dense" smoke, or "black" or "dark gray smoke," etc., from chimneys; but all such phrases are indefinite and can be too easily perverted to let favored parties escape and to punish those who are not favored with a "pull" and will not purchase immunity. A city ordinance providing that the density of the smoke emitted by any chimney should not exceed that corresponding to No. 2 on the Ringelmann scale, would give a definite standard by which smoke inspectors could be governed. To burn soft coal without producing any smoke is impossible under practical conditions; but, on the other hand, proper appliances and good management can certainly prevent the emission of smoke of the density corresponding to Card 4. If a smoke ordinance requires impossibilities, it is bound to be a dead letter. If it is so interpreted as to reach only those whose chimneys emit smoke of positive blackness, it will not help much the general condition of a city's atmosphere. This scale, however, makes it possible to draw a line and state what will constitute good practice in smoke prevention.

We advise our readers who are interested in this subject to cut out these engravings and mount them on cardboard. By adding the pure white and pure black cards, they will have a complete working outfit for grading smoke by Prof. Ringelmann's system.

STATISTICS OF STREET RAILWAYS IN THE UNITED STATES.

We reprint from our contemporary, the "Street Railway Journal," the accompanying table showing the mileage and rolling stock of street railways in each state. The statistics from which the table was compiled were gathered, we believe, early in the present year. It will be seen that electric traction is rapidly driving out all other systems. The number of locomotives in the returns is chiefly due to the inclusion of elevated railways in the statistics. Of the horse-cars still in use nearly three-fifths are in New York, and a large proportion of these will disappear from the list when the change now in progress to the electric conduit system in New York city is completed.

The average capitalization of street railways in the United States is $45,400 per mile of track, of which $33,400 is in stock and $12,000 is in bonds. On the steam railways of the United States the average capitalization is about $61,000 per mile, of which about $28,000 is stock and about $31,000 is in bonds. Notwithstanding that their capitalization per mile is only about two-thirds as great as that of steam railways, their net earnings per mile, applicable to the payment of income on the capital invested, is, according to the best estimates available, considerably larger that the corresponding return per mile on steam railways.

THE MANCHURIAN EXTENSION OF THE TRANS-SIBERIAN RAILWAY.

Frequent mention has been made in the newspapers of the Eastern Railway of China; the result of an arrangement made between Russia and China, whereby the former government obtains the right to carry the Trans-Siberian Railway across Manchuria to Vladivostock, and thus avoid the long detour by way of the Amour River. The map here reproduced from "Le Genie Civil" will help enable our readers to understand the advantage to Russia—of this new location.

This line will be built by the Russia-China Bank, founded for this purpose under an imperial ukase of Dec. 16, 1896, and working under the title of the Railway Company of the East of China. The company has a concession lasting 80 years, and besides building the railway and operating it, it has the right to mine coal and other minerals found in Manchuria, and to conduct industrial and commercial enterprises. Its original capital is fixed at 5,000,000 roubles, and the Russian government guarantees the interest. The executive committee, with headquarters at St. Petersburg and at Pekin, is made up of a president, selected by the Chinese, and nine members elected by the stockholders. The actual work of construction is under the control of a Chief Engineer of the Russian Corps of Ways and Communication. The Russian Minister of Finance approves the appointment of the vice-presidents and chief and assistant engineers, and passes judgment upon the plans and supervises the work of construction. The Chinese government agrees to levy no tariff dues upon goods in transit from the Trans-Baikal region to Vladivostock; and merchandise coming from China into Russia, or going in the contrary direction, will pay one-third less duties than those imposed at regular Chinese ports. The Chinese also promise to protect the line against hostile attack in Manchuria. The company engages itself to operate the lines with trains at the same speed as upon the Russian sections of the line; to construct a telegraph line connecting with the Russian system, and to transport the Russian mail free. At the expiration of the 80 years, dating from the first operation of the line, the Chinese may enter into possession of the line; but after 36 years the Chinese government will have the right to acquire control by assuming all the expenses, debts, interest, etc. of the company; and in this second case the Chinese and Russian governments will both endorse the obligations existing between the company and the State Bank of Russia. Actual work was to commence on Aug. 28, 1897, and the line is to be opened in six years from that time.

STATISTICS OF STREET RAILWAYS IN THE UNITED STATES, 1897.

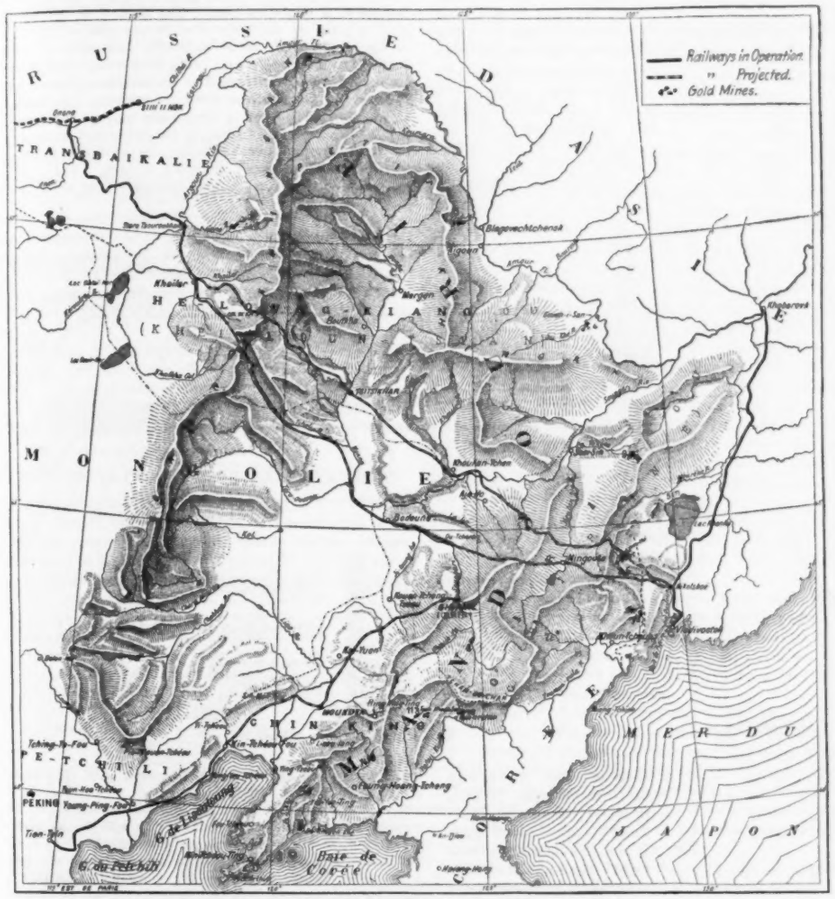
States.	Electric. Track mileage.	Electric. Cars. Motor.	Electric. Cars. Trail.	Cable. Track mileage.	Cable. Cars. Grip.	Cable. Cars. Trail.	Horse. Track mileage.	Horse. Cars.	Miscellaneous. Track mileage.	Miscellaneous. Cars, engs, etc.	Totals. Track mileage.	Totals. Cars.	Cap. stock per mile track.	Funded debt per mile track.
New England:														
Maine	152	225	87	..	...	...	3	4	...	...	155	316	$15,700	$15,900
New Hampshire	63	109	28	..	...	...	4	21	...	...	67	158	11,200	10,000
Vermont	35	45	4	..	...	...	..	...	...	...	35	49	14,300	11,500
Massachusetts	1,325	4,286	194	..	...	...	33	444	6	3	1,364	4,927	28,800	17,800
Rhode Island	158	476	152	..	...	...	..	1	...	...	158	629	52,900	54,700
Connecticut	372	850	95	..	...	...	..	15	...	...	372	960	26,000	24,100
Total	2,105	5,991	560	..	...	...	40	485	6	3	2,151	7,039	$28,400	$21,100
Eastern:														
New York	1,559	4,921	814	55	1,214	55	298	2,939	173	2,052	2,085	11,995	$92,700	$85,100
New Jersey	653	1,422	196	2	2	..	21	66	...	...	676	1,686	53,500	53,300
Pennsylvania	1,658	3,510	285	27	156	..	14	143	10	7	1,709	4,101	83,100	45,100
Delaware	32	85	....	..	....	....	..	....	...	...	32	85	19,200	23,400
District of Columbia	83	245	253	28	142	234	44	211	...	...	155	1,085	94,800	31,100
Maryland	285	761	136	21	72	36	2	100	2	2	310	1,107	43,500	43,700
Virginia	184	291	63	..	...	...	9	25	4	5	197	384	28,300	29,500
West Virginia	41	38	4	..	...	...	6	8	9	24	56	74	27,500	13,600
Total	4,495	11,273	1,751	133	1,586	325	394	3,492	198	2,090	5,220	20,517	$78,000	$60,600
Central:														
Michigan	494	1,121	166	..	...	...	..	...	3	4	497	1,291	$18,500	$21,300
Ohio	1,174	2,347	960	45	251	108	10	21	3	13	1,232	3,700	53,100	22,300
Indiana	343	494	230	..	...	...	12	30	...	...	355	754	29,300	26,800
Kentucky	178	331	228	..	...	...	40	125	...	...	218	684	34,500	30,600
Wisconsin	282	458	79	..	...	...	4	2	...	...	286	539	33,000	31,600
Illinois	1,113	2,124	2,702	82	617	522	28	109	20	229	1,243	6,303	83,700	63,600
Minnesota	292	671	318	7	40	...	4	6	...	6	303	1,041	62,100	45,000
Iowa	219	283	154	...	...	...	11	22	2	4	232	463	34,800	18,500
Missouri	489	982	696	101	326	490	24	62	...	...	614	2,556	48,000	53,500
Total	4,584	8,811	5,533	235	1,234	1,120	133	377	28	256	4,980	17,331	$52,700	$38,800
Southern:														
North Carolina	39	50	12	..	...	...	2	3	2	...	43	74	$14,200	$16,500
South Carolina	10	12	4	..	...	...	35	93	...	...	45	109	10,300	4,000
Georgia	224	325	42	..	...	...	11	9	9	10	244	386	18,000	19,000
Florida	43	40	10	..	...	...	11	16	...	...	54	66	6,000	100
Alabama	88	111	68	..	...	...	14	42	83	107	185	328	20,800	14,400
Mississippi	6	3	8	..	...	...	12	17	2	28	20	56	9,700	1,000
Tennessee	216	345	91	1	2	...	5	12	10	10	232	400	21,300	17,300
Louisiana	172	470	4	..	...	...	13	19	6	58	191	551	59,400	48,000
Arkansas	40	59	41	..	...	...	29	57	5	...	74	157	20,700	13,300
Total	838	1,424	280	1	2	...	132	268	117	213	1,088	2,187	$27,100	$20,700
Western:														
South Dakota	7	3	3	..	...	...	6	7	...	...	13	13	$21,100	$5,800
Nebraska	187	210	206	..	...	...	23	24	...	...	210	440	40,200	21,000
Kansas	107	118	77	..	...	...	22	30	...	...	129	225	20,300	16,100
Texas	267	337	56	..	...	...	54	129	...	...	321	522	18,500	15,700
Colorado	207	269	213	30	62	80	7	5	22	4	266	633	38,900	36,500
Montana	47	36	16	2	4	1	..	1	...	...	49	58	34,700	25,500
Idaho	4	2	..	..	...	...	..	..	...	...	4	2	13,500	...
Utah	92	105	17	..	...	...	..	..	8	2	100	124	17,600	10,000
Washington	210	186	18	18	45	15	4	6	...	...	232	270	38,200	26,700
Oregon	114	186	28	3	16	...	5	4	21	14	143	248	17,600	15,600
California	501	708	119	117	661	48	127	316	67	71	812	1,923	53,000	29,100
Total	1,743	2,160	753	170	788	144	248	522	118	91	2,279	4,458	$37,600	$24,400
United States	13,765	29,650	8,877	539	3,610	1,589	947	5,144	467	2,653	15,718	51,532	$53,800	$40,300
Canada	498	836	376	..	...	...	12	33	...	...	510	1,245	33,400	12,000

On the map two locations are shown, of which the first is the best known and studied. Both of these lines leave the Trans-Siberian Ry. at the Onone Station, and follow a common route to Khailar, passing the Russo-Chinese frontier at the village of Staro-Tzouroukhaitou. At Khailar the elevation above the sea is 1,978 ft., and the northern location reaches an elevation of 3,219 ft. in passing the summit of the dividing range and reaching Tsitsikhar. From this point to Khonlan-Tcheu the local conditions are good and the road can be easily built; but from the last-named place to Nikolsoe, on the existing line to Vladivostock, it traverses a country covered with forests, and a marshy, treacherous soil, which present certain difficulties. Many bridges will be required; but immense forests of virgin timber will be opened up to commerce.

The Southern location, from Khailar, ascends the mountain, and then descends into the fertile valleys of the Tchol and Nona, to Bodoune; and from this place the line passes through about the same country as on the north location, to Nikolsoe. The length of these two lines is about the same, and is about 1,287 miles (1,950 versts). The estimated cost of construction, without rolling stock, is 50,000 roubles per verst, not quite $60,000 per mile, with the rouble taken at $0.77 gold. As compared with the original location down the Amour, the distance to Vladivostock will be shortened about 800 versts, or 528 miles, by the Chinese location. This is shown by the following comparative lengths of divisions on the Trans-Siberian Railway, under the old and new locations:

Divisions.	Old line. versts.	New line. versts.
West Siberian	1,322	1,322
Central Siberian	1,731	1,731
Circum-Baikal	293	293
Trans-Baikal	1,059	930
Amour	2,000	
North Oussouri	341	
South Oussouri	378	102
East Chinese Railway		1,950
Totals	7,124	6,328

As the East Chinese railway replaces the Amour division, the actual length of line to be constructed is virtually the same, or 1,950 to 2,000 versts; but the cost of construction on the Amour was estimated at 117,000,000 roubles, and this figure would probably be increased, while the estimated cost of the Manchurian line will not exceed 100,000,000 roubles, according to the engineers.



MAP OF THE PROJECTED EASTERN RY. OF CHINA.
Reproduced from "Le Genie Civil."

Kelly stated that if the assessment valuation of the property in the district had remained the same as it was in 1896, the receipts from taxation should have been $3,619,000 nearly, and the bond issue could have been kept up to $12,065,000. The best information now available shows that the assessed valuation of the district has been reduced to $231,000,000, on which the Board can predicate the bonds to the amount of $11,550,000 only, which curtails the available resources by $615,000 in bonds and $150,000 for 1897 from taxes, the same probably for 1898 and 1899, or a total of $450,000 less in taxes and a total reduction of $1,065,000. It will be seen that the Board will pass into the year 1899 with a deficit of $2,575,578, which will have to be tided along until it can be wiped out by the income which will be available within that year, an income which will be in excess of the liabilities shown in the report by $774,421.

The tabular statement, which is given below, is brought down to Oct. 1, 1897, and shows that nearly $25,000,000 have been expended on this work, of which $19,000,000 has been for engineering purposes, the balance being for right of way and administration. It is estimated that by January, 1899, the expenditures will have reached nearly $31,500,000. This statement was compiled from the accounts shown upon the books of the respective departments, and from estimates and other information. It was prepared and signed by Mr. Isham Randolph, Chief Engineer, and Mr. James Reddicks, Clerk:

FINANCIAL STATEMENT OF THE SANITARY DISTRICT OF CHICAGO.

At a meeting of the Board of Trustees of the Sanitary District of Chicago, on Oct. 27, the President, Mr. Thomas Kelly, presented a statement showing the necessity of exercising economy on account of a probable reduction in the income for the next two years, and he also submitted a tabular statement of financial and other statistics revised to Oct. 1, 1897, which we give below. Mr.

Financial Statement and Estimates, Revised to Oct. 1, 1897.

Engineering account, administration	$1,062,800.26
Engineering account, construction	18,397,808.55
Engineering account, labor, section E	12,978.24
Engineering account, labor, section F	21,659.57
Engineering account, total expenditures	$19,495,336.62
Pumping plant, sections 3, 4 and 14 (maintenance account)	49,355.24
Law department, administration	285,724.35
Right of way land account	2,558,650.40
Total, law department	$2,844,374.93
Clerical department, administration	71,457.12
Treasury department, administration	11,849.33
Police department, administration	191,670.55
General account	350,970.13
Total expended under above heads	$23,015,013.92
Interest account, bonds	$1,620,346.42
Interest account, loans	2,163.52
Interest account, tax warrants	149,826.18
Total interest account	$1,772,336.12
Total expended for all accounts	$24,787,350.04
Available cash:	
Emergency fund	$12,000.00
Balance in treasury	520,870.26
Total	$532,870.26
Total net receipts	$25,320,220.30
Cost of work as shown by existing and completed contracts and estimated requirements Oct. 1, 1897:	
Construction account, completed and existing contracts	$19,793,569.58
Administration to Oct. 1, 1897	1,974,471.92
Administration, Oct. 1, 1897, to Jan. 1, 1899	325,000.00
Work to be done but not yet under contract:	
Tail race, Lockport, as per bid received	$522,007.84
Wheel pits, Lockport, estimated	100,000.00
From tail race to upper basin	150,000.00
Construction and right of way, Joliet	1,760,000.00
Movable bridges for railways and highways	1,511,368.98
Chicago River Improvement, construction	386,000.00
Total new work covered by plans	$4,429,376.82
Total estimated cost of construction and administration	$26,522,418.32
Right of way account:	
Expended for right of way to Oct. 1, 1897	$2,558,650.40
Chicago River right of way, estimated	115,000.00
Total land account	$2,673,650.40
Total for construction, administration and land	29,196,068.72
Contingent fund	500,000.00
Interest account to Oct. 1, 1897	1,772,336.12
Total	$31,468,404.84
Total expenditures to Oct. 1, 1897	24,787,350.04
Balance required to complete, exclusive of interest and bond retirement	6,681,054.80
Interest and bond retirement to Jan. 1, 1899:	
Interest tax warrants for 1896 and 1897	$90,000.00
1896 tax warrants to be redeemed	566,352.91
Bonds to be retired to Jan. 1, 1899	1,217,500.00
Bonds' interest to Jan. 1, 1899	831,512.50
Total interest and bond account	$2,705,365.41
Total obligations to Jan. 1, 1899	$9,386,420.21
Resources:	
Cash on hand Oct. 1, 1897	520,870.26
Balance of 1896 tax levy, in process of collection	1,014,125.72
Tax levy of 1897, less delinquents	$3,350,000.00
Tax levy of 1897, less warrants	1,422,903.78
	1,927,096.22
Tax levy of 1898, 75% of same in warrants	2,598,750.00
Bonds to reissue, Jan. 15, 1897	150,000.00
Bonds to reissue, July 15, 1898	150,000.00
Bonds to reissue, Jan. 1, 1899	450,000.00
Total assets available to Jan. 1, 1899	$6,810,842.20
Deficit at Jan. 1, 1899	2,575,578.01
75% of the tax levy of 1899 will be available shortly after Jan. 1 of that year	2,598,750.00
And 25% of the tax levy of 1898 should be available within the year 1899	751,250.00
Total assets available to meet liabilities in 1899	$3,350,000.00
Deficit at Jan. 1 as shown	2,575,578.01
Balance available for operating expenses	$774,421.99
The assessed valuation of property in the district for 1896 was	241,324,319.00
The estimated valuation for 1897 is	231,000,000.00
Bonds now outstanding	11,860,000.00

THE PATTON GASOLINE-ELECTRIC MOTOR FOR STREET RAILWAYS.

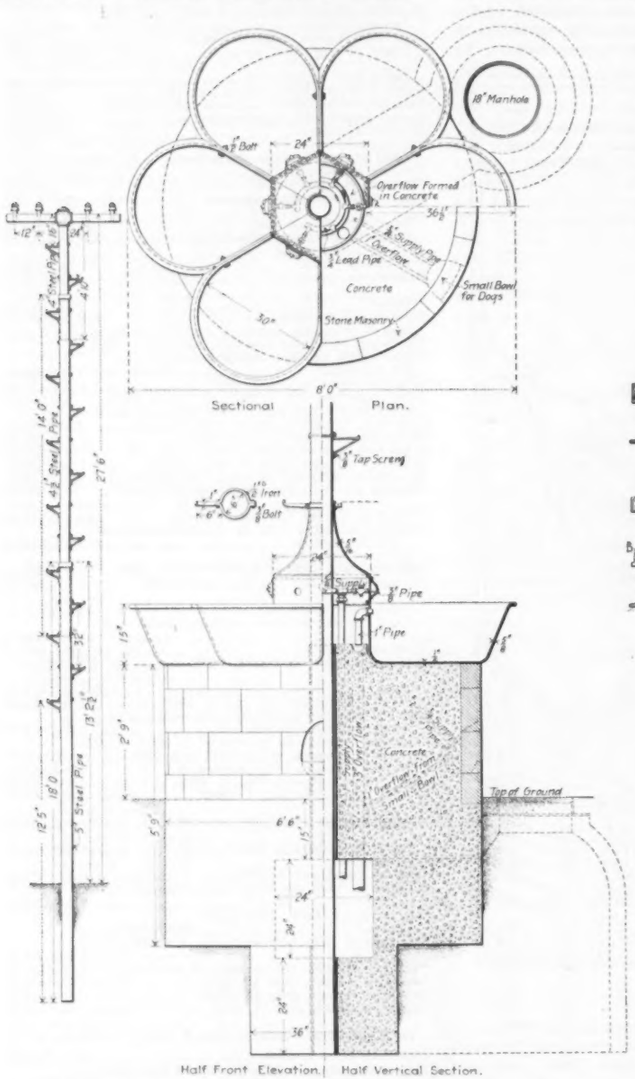
The Patton motor is a self-contained motor car driven by electricity which is generated by a gasoline engine and electric dynamo on the car. As the engine and dynamo runs continuously at a uniform speed, a storage battery is used to take up the surplus current and to give a constant load

on the engine. Thus the entire current generated when the car is at rest, or the excess current when the car is running but not utilizing the full capacity of the plant, is used to charge the storage battery, and the battery, in turn, supplies extra current when the machine requires more power than is furnished by the normal capacity of the dynamo. The car can also be run by the battery alone if required. This system is claimed to be especially adapted for lines with light traffic, as it does not necessitate any expense for a power station or for poles and wires along the line, and the track is not bonded for an electric current. These motor cars are built by the Patton Motor Co., of Chicago.

An exhibition run of a Patton motor, built for a street railway now under construction at Cedar Rapids, Ia., was given at Chicago, on Nov. 2. The motor started from the shops of the Street's Stable Car Co. (where it was built), at 47th and Morgan Sts., and hauled an ordinary railway passenger car of 30 tons weight, with a large party on board, and ran over some of the railway lines near the stockyards and along 39th St. The speed was from 6 to about 15 miles per hour. This motor is a four-wheel car, with a two-cylinder Raymond gasoline engine of 25 HP. mounted in the middle of the floor, the axle being parallel with the center line of the car, and directly connected to a Crocker-Wheeler dynamo rated at 25 HP. Each axle is driven by a 35 HP. Baxter motor, and there is a Baxter controller at each end of the car. The storage battery consists of 100 cells, 50 at each end of the car, the cells being furnished by the Electric Storage Battery Co., of Philadelphia, Pa. The gasoline engine has a water jacket for the cylinders, and consumes about 2½ gallons of gasoline per hour, while a supply of 25 gallons, or enough for a ten-hour run, is carried on the machine. The battery alone, when fully charged, could run the car for about 15 miles, but normally it acts only as a reservoir for surplus current. A hand brake is used, as on ordinary electric cars. The weight of the machine is about 15 tons.

The line at Cedar Rapids, for which this motor was built, will be five miles long, of which three miles will be in the city, with an extension of two miles out to the State Normal School, and the Patton motor was adopted on account of the city prohibiting the use of the overhead wire electric system. It will haul ordinary street cars, and at night it will haul coal and freight to the Normal School. A similar engine has been built for a line in the east and a company is now arranging to build a larger and more powerful machine.

During the construction of the Suburban Ry., of Chicago (which is operated on the overhead trolley wire system), a Patton motor was used for about three months in hauling material, stringing the wires, and hauling a heavy construction tower car for putting up the overhead trolley wire fixtures. Mr. I. B. Walker, Electrical Engineer of the road, states in a letter that the motor hauled from one to five freight cars, part of them being heavily loaded, and that the service was very severe, while he was surprised at the reliability and economy of this system. It used about 15 gallons of gasoline per day of 10 hours, at a cost of 6¼ cts. per gallon, or 94 cts., which, with $2 for the motorman's wages, brought the cost of operation up to $2.94 per day. Previous to the use of this motor a steam locomotive was used at a cost of $13.00 per day (1½ tons of anthracite at $5, $7.50; engineman, $3.50; fireman, $2). This motor was made by equipping an open trailer with the necessary plant, and at times of specially busy work on the construction it ran for 66, 36 and 24 hours without stopping work.



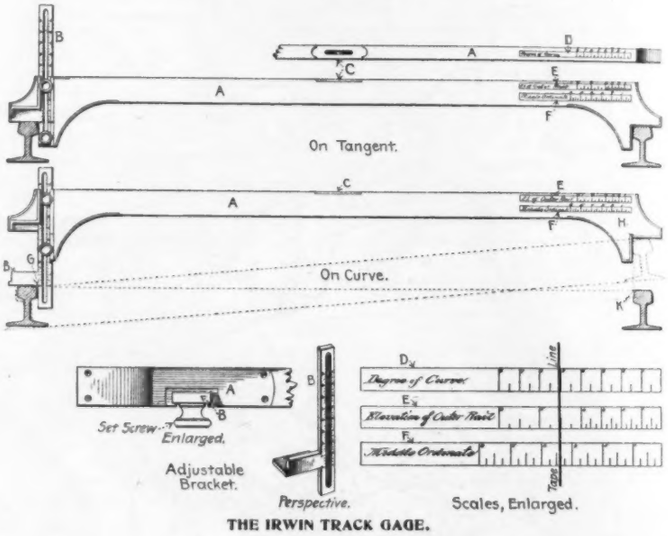
STREET FOUNTAIN OR PUBLIC WATERING TROUGH, ROCKFORD, ILL.
Chas. C. Stowell, City Engineer, Designer.

PUBLIC STREET-WATERING TROUGH, ROCKFORD, ILL.

The accompanying cut illustrates a street fountain or watering trough used at Rockford, Ill., which seems to possess several meritorious features in its construction, besides being of an unusually neat and compact design. This fountain was designed by the City Engineer, Mr. C. C. Stowell, and it cost, including patterns, about $200, but as the patterns are owned by the city, the cost will be considerably reduced in future constructions. Regarding this fountain, Mr. Stowell has sent us the following additional information:

Before designing the trough we consulted the catalogues of several dealers in goods of this kind, but found nothing that met our idea for a trough for this place, either in design or price. As constructed, each section is independent of all others. By this arrangement a slobbering horse does not contaminate the remaining sections, and should one section be broken the use of the trough is not destroyed and the cost of repairs is reduced to a minimum. The patterns are of small size, and convenient to handle at a minimum cost. The hood is of two pieces, held in place by the lower step on the pole, so that it is easily removed to allow inspection and repairs to the supply and discharge pipes. The foundation being of concrete made it possible readily to provide a dog trough, supplied by the overflow from the sections. A manhole at one side and extending two-thirds through the foundation gives access at all times to the sewer and water pipes below the ground line, obviating the necessity for excavating around the tank to make repairs. The electric light pole is held rigid in the opening in the concrete by small wedges, so that it can be removed with little trouble if it is desirable to do so.

Should a smaller trough be desired, one-half of the number of sections can be used. This will be the better form where one side only can be approached. The present trough accommodates 12 horses at one time. We used a cut stone facing to obviate the necessity of making a form for the concrete, but, of course, brick can be used as well as stone, or a form used in place of either. In our next fountain we shall use a form and make the foundation entirely of concrete, as it will reduce the cost and give a better appearing structure than brick, and about as handsome a one as cut stone. With this, as with any similar structure, local conditions will determine the best method of construction. We have plenty of good sand and gravel for making concrete, while the native stone and brick are not suitable for the purpose; but another locality might furnish the stone or brick, and not the sand and gravel for concrete work.



THE IRWIN TRACK GAGE.

THE IRWIN TRACK GAGE.

An improved track device which attracted considerable attention at the recent annual convention of the Roadmasters' Association of America was the Irwin track and curve elevation gage, which is illustrated herewith. The gage resembles an ordinary track gage, with a vertically adjustable foot or bracket at one end so that the bar of the gage may be set level on a curve, as shown. This bracket has a graduated scale to show the proper amount for the superelevation of the outer rail on a curve of any degree, and is held in any

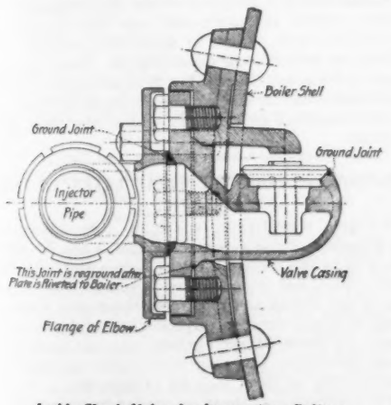
desired position by means of set screws. The special feature of the gage, however, is the insertion of three scales at the other end of the gage. Two of these, on the side of the gage, give the middle ordinate and the elevation of the outer rail; the third, on top of the gage, gives the degree of curve. These scales are plotted for use with a 50-ft. cord or tape. For use in curve work, the gage is set on the rails in the usual way, and the 50-ft. tape stretched across it, touching the gage side of the rail head at each end, with the 25-ft. mark over the gage. Then the readings of the three scales at the point where the tape crosses will give (1) the degree of curve, (2) the proper elevation of the outer rail for this degree of curve, and (3) the middle ordinate of the curve. When this proper elevation is thus ascertained, the adjustable bracket is lowered that amount, and set on the lower or inner rail, and the outer rail then raised until the spirit bubble in the center of the gage shows that the gage is set level. This lowering of the bracket also effects a widening of the gage of track on curves, the distance (or gage of track) G H (on the curve) being greater than G K (on the tangent). There is, however, no uniform practice as to this widening on different roads.

In the cut given herewith A is the bar of the gage, B the adjustable bracket and C the spirit level; D is the scale (on top of the gage) giving the degree of curve; E and F (on the side of the gage) give the middle ordinate and the superelevation. In the enlarged view of these scales the tape is supposed to cross at the point marked, indicating a curve of 5°, a superelevation of 4½ ins., and a middle ordinate of 3⅜ ins. The elevation scale can, of course, be plotted to suit individual opinions as to the proper rate of elevation.

This gage is the invention of Mr. Clarence E. Irwin, of the St. Louis, Iron Mountain & Southern Ry., and is being introduced by the M. M. Buck Mfg. Co., manufacturers of and dealers in railway supplies, St. Louis, Mo.

AN INSIDE CHECK VALVE FOR LOCOMOTIVE BOILERS.

The dangers incident to the use of the ordinary outside check valves on locomotive boilers, are pretty generally recognized, these valves being very liable to be knocked off in case of an accident or wreck, allowing an escape of steam and boiling



Inside Check Valve for Locomotive Boilers.

water from the boiler which may result in death or serious injury to trainmen or passengers caught in the wreck. While the ordinary outside valve continues to be largely used, some railways have already adopted and applied inside valves, and we illustrate herewith a form of inside check valve which is already in use on a large number of locomotives on the Pennsylvania R. R.

A flanged ring is riveted to the boiler shell, and has a circular recess in the face to which the brass valve casing is secured by tap bolts. This valve casing projects inside the boiler and carries a horizontal disk valve with ground joint, the vertical lift of the valve from its seat being limited by a finger projecting from the riveted ring. The flange of the elbow is bolted to the valve casing and ring and the elbow has a ground joint where it fits the valve casing. To the elbow the injector pipe is attached in the usual way. The force of the feed water raises the valve from its seat, and serves to wash the valve seat and reduce the deposit of sediment to a minimum. When the injector is shut off the valve falls to its seat by gravity, thus avoiding the objections incident to hinged valves. The flange on the elbow projects slightly into the boiler jacket, and when this is taken off the valve casing can be removed through the hole in the jacket, without disturbing or removing the jacket. The connection of the pipe elbow with the flange is purposely made light, so as to give way in case of an accident, without breaking or loosening the valve casing.

This device is one of the specialties of the Q. & C. Co., of Chicago, and the company states that the check valve was developed on the Pennsylvania R. R., and after passing through the experimental stage has been adopted by that road as its standard.

BEHAVIOR OF THE QUEEN LANE RESERVOIR, PHILADELPHIA, SINCE RE-LINING IT WITH ASPHALT.

The work of re-lining the Queen Lane reservoir, Philadelphia, with asphalt, is now complete. The work in the south basin was finished in September, 1896, and the full head of 30 ft. was reached during last March. Evidences of leakage appeared in the adjacent fields, but they have perceptibly diminished under the nearly constant head of about 18 to 20 ft., which has since been maintained. Exact measurements have been prevented by the fact that the basin has been constantly in service.

The re-lining of the north basin was completed on Aug. 16, 1897, and water was at once admitted. The full depth of 30 ft. was reached on Oct. 26, but here, also, evidences of leakage appeared. The basin was accordingly drawn down to about 20 ft. depth. Subsequent hook-gage observations indicate that, at that depth, the loss, after deducting evaporation amounts to about ½ in. per day.

As neither basin has been emptied since the relining was completed, the character of the leakage is not positively known; but the facts, that it comes to the surface in several places and is distributed over considerable areas, and that the water escaping is invariably clear, indicate that the loss, as before, is from percolation through the entire surface, rather than from true leakage through an aperture.

As originally constructed, each basin was lined with 2 ft. of clay, on both floors and slopes; and this was protected, on the slopes, by cement concrete slabs, 6 ins. thick at top, 12 ins. thick at bottom, 10 ft. wide and 67 ft. long; and on the floor by 4 ins. of cement concrete.

Before beginning the asphalt lining, the foot of the concrete slabs on the slopes was underpinned, throughout the entire circumference of each basin, with a concrete footing wall 2½ ft. thick, extending down to the micaceous rock underlying the site; which, however, was, in some places, decomposed to depths to which it was not deemed advisable to carry the footing wall.

The asphalt work consisted of 2 ins. of asphalt concrete on the floor, with a top coat of melted asphalt; and two coats of melted asphalt, with burlap between them, on the slopes. The burlap strips were anchored at the top of the slope. The slope-work is protected by a layer of hard bricks, laid flat and without mortar.

We are indebted to Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E., Chief of the Bureau of Water of Philadelphia, for the above information.

A SEARCH-PARTY FOR ANDREE and his companions, in his attempted balloon trip to the North Pole, has been sent out from Tromsoe under instructions from King Oscar of Sweden. The steamer carries 15 men under experienced leadership, and is provisioned for eight months. The party will search Daumandsoeren, Advent Bay, Cape Thorsem, Prinz Carl Foreland and possibly Dane's Island, from which Andree started last July.

SHEET ALUMINUM IS NOW CHEAPER THAN sheet brass for sheets of equal size and equal thickness. According to a circular just issued by the Pittsburgh Reduction Co. the price of aluminum sheet in widths from 6 to 14 ins. and No. 19 or any heavier gage, is 38 cts. per lb., with discounts of 10 and 5% on quantities of 4,000 lbs and over, making the net price 32.49 cts. per lb. The base price of sheet brass is 22 cts. per lb., with a discount of 45% to ordinary customers, making the net price 12.1 cts. per lb. Special extra discounts on large lots of 5½% reduces this to 11.438 cts. per lb. Sheet brass is 3.19 times as heavy as aluminum, so that bulk for bulk, or square foot for square foot of sheet of the same thickness, the price of brass as compared with aluminum would be as 11.438 × 3.19 or 36.169 cts., to 32.49 cts. for aluminum. The aluminum is, therefore, 10% cheaper than the brass sheet per square foot.

The same circular quotes aluminum in ingots, guaranteed to be over 99% pure, in ton lots at 34 cts. per lb., and nickel aluminum casting metal, which is pure aluminum alloyed with less than 10% of nickel and other ingredients, 33 cts. per lb. A special casting alloy containing over 80% aluminum, used in place of brass, is quoted at 27 cts. per lb. These reductions in the price of aluminum should lead to a great increase in its use in the manufacture of articles for which sheet brass has been heretofore employed.

THREE LARGE PASSENGER LOCOMOTIVES have been built for the Southern Ry. Co., and will be used to haul the Royal Florida Short Line limited train running between New York and St. Augustine, Fla. The principal dimensions of these locomotives are as follows:

Driving wheels, diameter	6 ft.
Total weight of engine and tender	117½ tons
Weight on drivers	58 "
Weight on trucks	17 "
Weight of tender	42½ "
Capacity of tank	4,500 gals.
Cylinders	21 × 28 ins.
Working steam pressure	200 lbs.
Diameter of boiler	5 ft. 2 ins.
Total heating surface	2,298 sq. ft.
Dimensions of fire box	10 × 3½ ft.

It will be seen that the weight on each driver is 19½ tons. The driving axles are 8½ ins. in diameter and 11 ins. long.

THE HAVANA FLOATING DRY-DOCK, built in England and despatched some time ago to Havana, reached that port on Nov. 7 without damage.

SPECIFICATIONS FOR A NEW WATER SUPPLY FOR Jersey City have been approved by both the Street and Water Commissioners and the Board of Finance. They provide for the reception of bids six weeks after the approval of the specifications by Mayor Hoos. The latter must take action some time during the current week. The main features of the specifications were outlined in our issue of Sept. 30, 1897. Mr. Garwood Ferris, of Jersey City, is Consulting Engineer to the Street and Water Board, and Mr. C. C. Vermeule, 203 Broadway, New York city, is Consulting Engineer to the Board of Finance.

CIVIL SERVICE EXAMINATIONS for positions in the Department of Public Works of New York, N. Y., will be held as follows: Inspectors to supervise elevators in Building Department, Nov. 9; architectural draftsmen, Nov. 10; dynamo engineers, Nov. 12; inspectors of electrical wires and appliances, Nov. 16; inspectors of water meters, waste water and supply to shipping, Nov. 18; inspectors of pipe and pipe laying, Nov. 22. The Secretary of the Civil Service Commission is S. William Briscoe, New Criminal Court Building, New York, N. Y.

THE BUSK TUNNEL, completed in 1893 by the Busk Tunnel Ry. Co., and used since that time by the Colorado Midland R. R., will, it is stated, be abandoned by the railway company, which will resume running its trains over the old Hagerman tunnel route. The Busk tunnel and the old Hagerman pass route, which it was built to replace, were fully described in our issue of Sept. 27, 1894. The tunnel cost $782,000 alone, and its construction saved the railway 6.93 miles in distance, 575.7 ft. in elevation and about 2,000° in curvature over the old route. It was built under a contract by which the Colorado Midland R. R. agreed to use it and to pay a toll of 25 cts. per ton for freight and 25 cts. per passenger. This contract will be broken if the reorganized company now controlling the railway abandons the tunnel, and it is stated that the tunnel railway company will claim heavy damages in the courts.

THE STRICKLER TUNNEL, being excavated through Pikes Peak, Colorado, to provide the city of Colorado Springs with water, is progressing favorably at present. A full description of the work was published in our issue of Aug. 27, 1896. The tunnel has a section 7 ft. high and 4 ft. wide, and is 6,427 ft. long. Excavation is now progressing at the rate of 30 ft. per day. Work is carried on from both ends, and about 2,000 ft. have been completed from the east end and 1,500 ft. from the west end. The material penetrated is rock. Wilson & Jackson, of Chicago, Ill., are the contractors, and the work is being done under the supervision of Mr. H. O. Reid, City Engineer, Colorado Springs, Colo.

WIRELESS TELEGRAPHY is still being experimented with by the British postal authorities. It is stated that messages are now being sent and received at three miles distance, but the results are not nearly so satisfactory as they were at two miles, at which most of the experiments thus far have been made.

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Mailing addresses may be changed at will by sending both old and new address. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug. 12) of the year 1897; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page 28. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The report of the Supreme Court Commission presenting an unqualified approval of the plans for the New York City Rapid Transit Ry. is a matter for much gratification to all the friends of that important enterprise. If the report is confirmed by the Supreme Court the Rapid Transit Commission will be in a position to advertise for bids for the construction and operation of the road under the plan set forth in the law. The opposition to the enterprise has been due almost wholly to the efforts of a single newspaper; and while the present Rapid Transit Commission was created by the reform element in the city, headed by the Chamber of Commerce, the fact that the people at large earnestly desire municipal construction of a rapid transit system is shown by the rapid transit plank in the platform of the party which was placed in control of New York by the recent election. Unless new legal complications should arise, therefore, there seems good prospect of progress with the enterprise.

The Secretary of the Navy some time ago appointed a board of seven line and three engineer officers of the Navy to discuss and to report upon some equitable adjustment of the long standing differences existing between these two classes of officers. The Medical Bureau and the Chief Constructor's Bureau simplified the work of the board by stating that the officers of these corps did not insist upon actual rank, and the paymasters and civil engineers on the staff were seemingly not consulted at all. In any event, the Bureau of Steam Engineering was the only staff corps represented upon the board appointed. Under existing law the officers of this Bureau, though graduates of the Naval Academy and performing most important duties, are simply members of the general staff, do not possess any actual rank and are not clothed with the same authority over the enlisted men as is the officer of the line. Against this anomalous condition of full responsibility and limited power to exact obedience from the men the steam engineers have long contended; and at the first meeting of the present board notice was given that actual rank for those performing engineering duties would be insisted upon. Contrary to the general impression when the board was appointed, the members of the board seem to have at least reached the basis of an amicable settlement by the practical abolition of the corps of steam engineers. All engineer officers above a certain grade, not yet fixed, are to perform the duties of engineers alone until retirement; but officers below this grade are to be instructed in the full duties of the line officer, to divide their time between the deck and the engine-room, and after a time to be specified they cease to be engineers—that is, by title, and become line officers of the Navy as well as engineers. In like manner, line officers below a certain grade must study steam engineering and fit themselves for performing engine-room duty.

This means that in due course of time every actual officer of the Navy must be, theoretically at least, as good a steam engineer as he is a line officer; and from this point of view it is a decided confession of the equal importance of mechanical engineering skill in the successful management of a modern warship. But it also means the development of a very responsible class of petty officers aboard ship in the machinists of the Navy, who are enlisted men. The board now in session evidently proposes to relieve the actual officers in charge of the engine-room of much of the personal handling of the machinery, and to entrust this duty to the machinists. And if this latter class are paid sufficiently well to attract an intelligent and capable lot of men, this proposed readjustment of executive duties among the officers of the ship may serve its purpose. In modern naval affairs, however, the mechanical element is becoming more and more important; and unless this fact is fully recognized in the preliminary training of the officers, the abolition of a corps of specially educated and experienced engineers may cause trouble. Whatever conclusions the present board may arrive at will probably have to be readjusted under the test of experience; but the plan outlined is seemingly the only one acceptable to both classes of officers, and the only way of putting an end to a long-standing wrangle, which is in itself subversive of naval discipline. It is to be sincerely hoped, therefore, that this first agreement of the mixed board may result in the passage by Congress, of a law which will efficiently and equitably readjust the whole personnel of the United States Navy.

And in this final readjustment the law should also consider the claims of one other staff corps, that of the civil engineers, and put it on a parity with all the other departments of the Navy by heading it with a trained member of the corps itself. The civil engineers of the Navy, as we understand their position, desire no other rank than they now possess; but they are right in demanding that their chief shall also be an engineer, so trained and experienced as to understand his business, and able to direct them efficiently in their works.

The Circuit Court decision in the suit brought against the Trustees of the Chicago Drainage Canal by the contractors, Ricker, Lee & Co., which is summarized briefly in our news columns, illustrates anew the doubtful wisdom of trying to throw the burden of risk in certain classes of engineering work entirely upon the contractor. In this, as in many previous instances, experience has clearly shown that however carefully the agreement is drawn, the contractor is nearly always able to shift a portion at least of the loss, if it reaches any great amount, upon the party for whom the work is done. This, however, is but one of the two important lessons which are taught by this decision of the courts. Few engineers who have studied the circumstances can doubt, we think, that the whole controversy would have been avoided by following the sound engineering advice, which was deliberately disregarded by the Board of Trustees at the very commencement of the Drainage Canal work. It was clearly a very simple matter to have determined exactly the character of the material to be excavated, but the plan of the engineer to sink test pits for this purpose was overruled by the Trustees as an unnecessary labor and expense. Instead of large-sized test pits being sunk a series of 3-in. borings were made. Whether from inherent limitations of the method or from faults of operation or of recording the results, we need not stop to inquire now, but the fact is that these borings failed to determine adequately the nature of some of the most intractable material encountered on the earth excavations of the canal.

As many of our readers know, the contractors for several miles of the channel, among whom were Ricker, Lee & Co., after excavating several feet of the soft top soil, encountered a very hard material, which could not be handled with the strongest steam shovels without blasting, and whose real character was not suspected when the contracts were taken. The contractors applied for an increased price for excavating this material, claiming, what was doubtless true, that they could not afford to do the work at the prices bid on the supposition that all the material could be handled with steam shovels without blasting. The Board of Trustees' Committee on Engineering, after investigating the claim through its own engineers and by employing outside experts, presented a majority and a minority report advising opposite policies. The majority report advised that no concession should be made. This report was made in the face of the fact that the preponderance of the expert engineering opinion was to the effect that an increased price was just. The minority report, which was made by the only engineer member of the Board of Trustees, Mr. Lyman E. Cooley, urged strongly that an increased price for excavating the hardest material should be granted. The reasons presented in favor of this policy were, that all delay from litigation and time lost in re-letting the contract would thus be avoided; that the Trustees were in a measure a party to the error which had resulted in a hardship to the contractor and equity demanded that they should assume a part of the burden, and, finally, that if the matter was carried to the courts it was quite probable under the conditions that the contractor would get at least partial redress. The policy advocated by the majority report was adopted by the Trustees, and the contractors, Ricker, Lee & Co., brought suit for all the money, including their $50,000 bond, which had been withheld by the Trustees when the work was stopped.

The result of this suit is given in our news columns, as already stated, and it is particularly interesting to note that the arguments upon which the decision of the courts is based are almost exactly those presented by the engineer member of the Board of Trustees whose advice was wholly disregarded. The prophecy of the report regarding delay, it may also be noted, has been similarly confirmed. The danger of neglecting engineering advice on engineering questions has been made plain in numerous cases; but it is not often that a community has so quick a confirmation of the fact as is presented in the case which has been described.

WATERWAYS FROM THE GREAT LAKES TO THE ATLANTIC.

We give considerable space in this issue to an abstract of the report of Major Thos. W. Symons upon the proposed Great Lakes and Atlantic Ship Canal, and we commend it to our readers as one of the ablest and most comprehensive reports upon an engineering enterprise that we have ever seen. As many of our readers may not have the facts concerning this enterprise clearly in mind, a brief review of them may be of interest.

For several years those interested in transportation upon the Great Lakes have been talking of the possibilities of an outlet for the lake vessels to tidewater. An organization known as the Deep Waterways Association, composed of the principal business men in the Lake cities, has been very successful in securing government appropriations for deepening channels and harbors on the lakes, and has more recently devoted itself to arousing popular interest and enthusiasm in the project to build a ship canal to connect the lakes with the ocean.

No actual survey for such a waterway has ever been made. It has long been a favorite subject for discussion by engineers and others, and the relative merits of different routes have been more or less thrashed over; but the first real move toward a systematic collection of data on the subject was the adoption of a joint resolution by

Congress in February, 1895, creating a "Deep Waterways Commission" "to make inquiry and report whether it is feasible to build such canals as shall enable vessels engaged in ocean commerce to pass to and fro between the Great Lakes and the Atlantic Ocean." We reviewed the report presented by this Commission, the principal member of which was Mr. Lyman E. Cooley, in our issue of Feb. 11, 1897. Briefly stated, the Commission did not attempt to discuss the questions whether such a canal would pay, or what sort of a canal between the Lakes and the Atlantic would move freight most cheaply. It merely concluded that to meet the requirements laid down by Congress a 28-ft. channel would be necessary, and declared, with a very meager presentation of facts in support of the statement, that "the completion of the entire system as quickly as proper projects can be matured and economically executed is fully justified." In accordance with this view it recommended that complete surveys for a ship canal both by the Oswego-Oneida-Mohawk route and by the St. Lawrence-Champlain route should be made, together with surveys for improving the lake channels, etc., etc. The total estimated cost of these surveys was set at "not less than $600,000."

This recommendation was taken up by Congress, and in accordance therewith the Sundry Civil Appropriation bill, approved June 4, 1897, contained an item of $150,000

for surveys and examinations (including estimate of cost) of deep waterways and the routes thereof, between the Great Lakes and the Atlantic tidewaters, as recommended by the report of the Deep Waterways Commission.

As our readers are aware, these surveys are now in active progress under direction of Major C. W. Raymond, Corps of Engineers, U. S. A., and Messrs. Alfred Noble and Geo. Y. Wisner, Mems. Am. Soc. C. E.

But while the Cooley Commission created by Congress in 1895 was engaged in its work, Congress made another provision for tackling the same problem, apparently forgetting all about the Cooley Commission. The River and Harbor Act of 1896 authorized the Secretary of War to ascertain the cost of a ship canal from the Great Lakes to the Hudson, and very fortunately in such terms that the War Department was enabled to construe its instructions broadly and to undertake the solution of two questions which have never before been definitely and systematically studied: (1) Will a deep waterway from the Lakes to the Atlantic be of enough benefit in reducing the cost of transportation to warrant its construction. (2) What would be the most economical system of water transport between the Great Lakes and the Eastern cities and export points?

This journal has always contended that these questions should be given systematic study before detailed surveys and estimates of cost of such a work were undertaken; and further that these questions are properly engineering questions, and could only be properly considered and solved by a thoroughly competent engineer. It appears to us that Major Symons' masterly report is a complete vindication of our position, and we bespeak for this report careful and unprejudiced study by every one interested in this proposed enterprise.

Anyone must admit that no one can form sound opinions on any subject unless he is well informed as to the facts concerning it. No one can now claim to be well informed respecting the Deep Waterway enterprise unless he has familiarized himself with the facts given in Major Symons' report, and we believe that study of these facts will lead many who have been prominent in favoring the ship canal enterprise materially to revise their opinions.

Summed up in the fewest possible words, Major Symons' report shows that a deep waterway between the Lakes and the Atlantic large enough to give passage to ocean steamers would not result in a decrease in the cost of freight between lake ports and seaboard or foreign cities at all commensurate with its cost; and that a 12-ft. deep waterway sufficient to accommodate barges of 1,500-tons capacity, which could be built for a quarter of the cost of a waterway large enough for the lake steamers, would enable freight to be carried between the lakes and the seaboard as cheaply as it could be by a ship canal.

We some time ago pointed out that the agitation for a ship canal between the Great Lakes and the Atlantic was due very largely to the mistaken ideas that a mile of ship canal was equivalent to a mile of ocean navigation, and that if a channel of sufficient capacity were opened, freight carrying steamers of all nations would go to Duluth and Chicago and other upper lake ports to receive their cargos. It is a fascinating picture and it is not at all strange that a large proportion of the business men in the lake cities should have been led to believe in it; but in the light of the facts presented in Major Symons' report any unprejudiced man must see that it is a picture which cannot be realized. The owners of freight steamers will not send their vessels up a canal to the lakes for a cargo unless it pays them to do so; and it will not pay them to do so if cheaply built barges can take on loads at upper lake ports, make the run down the lakes and through a canal and deliver grain alongside an ocean steamer at a cost less than that for which she could make the trip herself.

Another fallacy which is commonly held is that ocean transportation is the cheapest transportation in the world. The figures in Major Symons' report show, however, that transportation on the Great Lakes is actually cheaper at the present time than transportation by ocean freight steamers. The average actual freight rates from New York to Liverpool for nine years past have been $1.81 per ton (of 2,000 lbs.) or 5.43 cts. per bushel of wheat. The average actual grain rate from Chicago to Buffalo for the past five years has averaged 1.37 cts. per bushel, or $0.45 per ton. The distance from Chicago to Buffalo is 929 miles. From New York to Liverpool it is 3,500 miles in round numbers. Thus the rate from New York to Liverpool is equivalent to 0.517 mills per ton mile, and the Chicago-Buffalo rate is equivalent to 0.484 mills per ton mile.

But the very low cost of lake transportation is not adequately shown even by this, for the distance from New York to Liverpool is more than three times as great as the distance from Chicago to Buffalo; and in all matters of transportation, the longer the haul, the lower the rate which can be made. Further, coal and iron ore are being moved on the lakes at rates lower even than the rates on grain. It is, therefore, a fact that freight is being transported on the Great Lakes at the present time at a much lower cost than is done on any transportation route in the world of similar length.

The reasons for this are obvious on a little reflection. It is partly because the lake freight vessels cost less for a given tonnage than the ocean vessels; but the main reason is the wonderful system by which vessels are loaded and unloaded with a dispatch that is unequalled anywhere in the world, unless it be by the tank steamships of the Standard Oil Co. The tramp steamship is not so built as to permit any such rapid receipt and discharge of cargo as the lake carrier, nor, indeed, can she be if she is to be stanch enough to withstand safely the gales of the North Atlantic, and if she is to accommodate a miscellaneous cargo, so that her owners can send her to whatever port they find most profitable.

Another fact which ought to be clearly kept in mind is that this lake transportation, the cheapest in the world, is being carried on with an available depth of water of only some 16 ft. The Cooley Commission declared that the construction of a 28-ft. channel by the Government was "justified." Yet the fact is that on 16 ft. of water the lake carriers are beating the world's records in economical transportation. A 16-ft. channel would cost hardly one-fourth as much as a 28-ft. channel, and yet it would enable the present lake steamers to deliver their cargoes at tidewater without unloading. How, then, could the enormous cost of a 28-ft. canal be justified? Would its advocates expect the ocean steamers to ascend it and charge lower freight rates than they obtain in ocean navigation under world-wide competition?

But in the light of the facts made public in Major Symons' report, it appears that even the lake steamers would not be the cheapest freight carriers from the lake ports to tidewater. The economy of moving freight in barges is something with which lake owners have had experience, and Major Symons' interesting showing of the possibilities of barge transportation they can fully appreciate.

It is not so long ago that the McDougall barges made their appearance on the lakes and showed their ability to transport grain at prices before unheard of. In the Lake ore and coal trade the economy of handling vessels in tows is well understood. Barges of 1,500 tons capacity, such as Major Symons proposes, could take on cargoes at the lake ports and pass through a 12-ft. depth canal to tidewater at New York, and thence could go north to all points on Long Island Sound and south to all points on Chesapeake and Delaware Bays. For the domestic trade (which is much more important than the export trade) this would, of course, mean the transfer from upper lake ports to the port of destination without breaking bulk. For the export trade there would be the single transfer to the steamer at New York. This proposition is not based on guess work but on facts and recorded experience. It only waits the construction of the necessary waterway to become a reality.

The question now arises, What will Congress—what will the country do with this enterprise? The Commission which is now expending $150,000 upon surveys, if we are rightly informed, considers itself bound by the language of the appropriation bill to follow the lines laid down by the Cooley Commission, and will make surveys, plans and estimates for the 28-ft. ship canal which that body recommended. The uselessness of the work, in large part, at least, seems evident in the light of the facts which Major Symons has set forth. Certainly no sane capitalist would invest his money in a 28-ft. ship canal to accommodate fleets of 10 or 12-ft. draft barges; and it is in the highest degree improbable that the United States would undertake such a work.

It appears to us that what is actually done about this enterprise will depend very much upon the lake navigation interests, whose agitation is chiefly responsible for what has thus far been done. If they have the wisdom to see that the much-talked of ship canal is but an iridescent dream; and that what is really wanted is that waterway which can move freight from the lakes to the seaboard at the least total cost, they can effectively aid in carrying out the project which Major Symons has recommended, by concentrating their efforts in that direction.

It is to be borne in mind that the investigation which Major Symons has made is only a preliminary inquiry. As he himself explicitly states, the barge canal which he proposes is only a first approximation toward the most economical vessel and waterway for this avenue of traffic. Fuller investigations might show that a channel either somewhat larger or somewhat smaller would be more economical. The work which Major Symons has so well begun should be carried to completion, preferably under his direction, since he has so well proved his competence; and when the most economic size of channel has been determined, then surveys and estimates in detail should be undertaken. The cost of the complete surveys for a barge canal on the line of the present Erie canal is estimated by Major Symons at only $125,000. If the advocates of a cheaper water transportation from the lakes to the seaboard really wish to have a new waterway made, they will do well to abandon their support of the impracticable ship canal scheme and turn their influence toward the construction of such a barge canal as Major Symons has recommended.

THE UNSATISFACTORY CONDITION OF GARBAGE DISPOSAL IN AMERICA.

Garbage disposal in this country is in a very unsatisfactory condition. Only a comparatively few cities have adopted any modern method of disposal and in many of these the cost of the work is altogether too high and complaints of nuisances from the disposal plants are frequently made. This deplorable state of affairs is largely due to

the fact that as yet the problem has not been approached in so thoroughly scientific a manner as have other problems in engineering. While scores of our most prominent engineers are connected with the development of water supply and sewerage systems, it would be hard to name three engineers of high professional standing who have designed any of the garbage disposal plants now in operation in this country, or taken any essential part in the evolution of such systems of garbage disposal as are now in use.

Nearly all the garbage furnaces in the United States have been evolved by mechanics and artisans of an inventive turn of mind, supplemented by suggestions from small capitalists and sales agents financially interested in the matter. Many of the different makes of furnaces, naturally enough, are but slight modifications of earlier makes. Of garbage utilization or reduction plants most have been developed by men connected with rendering establishments devoted to the production of grease and fertilizer from old bones and dead animals.

Both cremation and utilization systems are sadly in need of being taken in hand by competent engineers. The reasons why this has not already been done are various. The most important are that as a class the inventors in these lines have not been engineers at all and, like the vast majority of inventors, have been so possessed with their own ideas that they have failed to make any real study of the state of the art, further than in connection with trials of their own devices. Both these inventors and the small capitalists whom alone most of them have been able to interest have shunned engineers, partly through jealousy and partly because they did not wish, or thought they could not afford, to incur the expense of consulting them. This has been true of the inventors in both lines, but more true of the capitalists interested in cremation than those who have taken up utilization processes. Many of those who have become financially interested in utilization processes would not of themselves hesitate to spend money for the best engineering advice, but the inventors whom they have backed have declared such expenditures unnecessary and the capitalists themselves often yield to the temptation to work for the speculative profits arising from stock dealing rather than the slower, and perhaps smaller, returns from the business itself. Doubtless the speculative aspects of garbage utilization processes have contributed largely to keep our best engineers from taking up the subject. They could be induced to give their energies to the development of such systems only when allowed to work along scientific lines, whereas their possible employers have been unwilling to expend money for this purpose, through ignorance or impatience to realize quick profits instead of putting money into experimental researches for future returns. Where speculative ideas have ruled there has been little opportunity for work by an able and conscientious engineer. His services would be desired to bolster up a system, as developed, rather than to search out and remedy the weak points of a system.

In saying what we have we do not mean to convey the idea that there are no good garbage disposal plants or systems in this country. We believe that there are a few which either already have been or are capable of being brought to a high degree of perfection, although most of both plants and systems have many unsatisfactory features.

In this connection it is proper to refer to the conclusions of Mr. Rudolph Hering, M. Am. Soc. C. E., as expressed in his report as chairman of the Committee on the Disposal of Garbage and Refuse, of the American Public Health Association, which was published in our issue of Nov. 4. Mr. Hering conveys the idea that no fully satisfactory garbage disposal plant has been built in this country, as yet; that all utilization processes thus far in use are probably doubtful financial ventures, and are to be viewed with suspicion from a sanitary standpoint unless located so far from centers of population that any offensive odors from the process can give no trouble. Mr. Hering further seems to be convinced that the English type of garbage furnace is an unquestionable success, especially as shown by recent tests at Berlin and Hamburg, Germany. Now, what we have already said above agrees largely with Mr. Hering's evident conclusions regarding the general unsatisfactoriness of American garbage disposal plants. We think it probable, too, that the English type of garbage furnace comes the nearest of anything yet evolved to what a garbage furnace should be. We question Mr. Hering's conclusion that all utilization plants not remotely located must be looked on with suspicion, unless, indeed, the same rule is to apply to garbage furnaces. We believe that garbage utilization plants have been, or may easily be, designed and built in which the process is so continuous from the reception of the green garbage to the packing of the products that few or no offensive odors can possibly be given off, and in which such odors as do arise or can be subjected to some treatment rendering them unobjectionable. With this accomplished, why should a utilization plant be excluded from any locality where a crematory would be permitted? Reasons, largely sentimental, may relegate plants of either type to isolated locations, but on such grounds one would be tolerated no longer than another.

One other point in Mr. Hering's paper should be noted. He inclines to a combined removal and treatment of garbage, ashes and other refuse, stating, of course, that this is not possible where the utilization process is in use. Obviously it is simpler, and causes less friction to allow this mixing, as then only one receptacle is required for each householder. If cremation is to be employed the greater the amount of combustible matter mixed with the garbage the better, but in many cases probably it will be found advisable to draw the line at ashes. Alone, these are perfectly sanitary. They may be removed at less frequent intervals than is necessary for garbage, and as they are an excellent material for filling they generally need receive only a short haul. Now, the total cost of garbage disposal is largely dependent on the length of haul, so that economy may often demand the exclusion of ashes from garbage in order to reduce the cost of transportation. In addition, ashes may often prove so great a clog to a garbage furnace as to offset the fuel value of any coal they may contain. Mr. Hering rightly says in his report that no hard and fast rule can be laid down applicable to garbage disposal in all localities, and that sanitary considerations should always be placed before financial. He by no means condemns utilization, nor is he a partisan for cremation, but it does seem as though he regards utilization with too much suspicion.

Despite the criticisms we have made above, we most heartily commend Mr. Hering's report as a whole. His conclusions are based on a mass of statistical and other information, secured at great pains and expense, which it is to be hoped will speedily be made available to those interested. It is very probable that Mr. Hering would agree with us in believing that the promising results with cremation abroad, some of which were obtained in tests extending over but a few months, doubtless with rigid engineering supervision, do not indicate conclusively that as satisfactory results would be secured under the conditions of the average American city. Nevertheless these foreign examples are encouraging as showing what is possible when garbage disposal is conducted on a sound engineering principle rather than on a political or speculative basis.

LETTERS TO THE EDITOR.

Ideas of City Government at San Francisco.

Sir: The report of the Committee on Public Improvements of the Citizens' Charter Convention of One Hundred in San Francisco (See Eng. News, Oct. 14, 1897. —Ed.) has been discussed by the convention and been mangled in a way very displeasing to the members of the committee.

The object of the committee, in the first place, was to secure a Board of Public Works competent in every way to attend to the public works of the city. They did not dare to specify that all the members should be technically educated, but did require that one of the three commissioners should be a civil engineer of not less than ten years' experience. The first discussion was over the experience of the engineer, and some did not want any experience at all. Others thought three years and some thought five years would be sufficient. Ten years finally won by a very small majority, when one of the objectors brought in a resolution to do away with the engineer altogether.

This precipitated a discussion in which engineers were unmercifully roasted by members who believed that there were no men so susceptible to influence as civil engineers. It was a most shameful attack on a good profession, and when the question came up to a vote of permitting an engineer to be on the commission the profession won by two votes. The Freeholders yet remain to be heard from and they may eliminate the engineer.

The provisions relating to the creation of City Surveyors under bonds, responsible to clients for mistakes in lot surveys, was overwhelmingly defeated. Probably few cities in the Union have suffered as much as San Francisco in faulty surveys for building purposes, and there is no city in the Union to-day with such a large number of "curbstone operators" who survey lots for miserably small prices and are constantly embroiling builders and owners in law suits, yet an intelligent body of men deliberately snowed under a provision for the proposed new charter which would place responsibility.

The experience of the City Engineer was cut down from ten years to five and some of the members believed fresh graduates would be all right for the work. It seemed from the discussion that few members could be made to believe that an engineer was more than a surveyor. If more than a surveyor he is an "expert." There is need of education in the use of the term expert.

When the discussion on the charter first commenced it was determined that the Supervisors (Council) should have only legislative authority, the Mayor to have the executive. There was such a strong opposition to the Supervisors having anything to do with the executive branch of the government that the Committee on Public Improvements carefully prepared their report with this in view.

They provided for the Board of Public Works to be appointed by the Mayor and removable by him. It is likely the convention will require the removal to be approved by two-thirds of the Supervisors (of whom there will be no less than eighteen). If this is not mixing executive and legislative functions and leaving a loophole for jobbery our ideas of government are all wrong.

The committee provided that the Board of Public Works should have power to employ all the help needed and pay whatever salaries were required, but that they had to keep within the appropriation for the year. If dishonest the Mayor, of course, could remove. The convention changed the report to read that if even a chainman is required by the City Engineer the Board must make application to the Board of Supervisors to appoint him and the Board of Supervisors must fix the compensation also of all help required by the Board of Public Works.

The committee provided that all ordinances affecting the powers and duties of the Board of Public Works should originate in that Board and must be passed or vetoed by the Supervisors without amendment. The convention rejected that clause altogether and provided that the Board of Public Works must work in conformity with ordinances of the Board of Supervisors.

The City of San Francisco many years ago voted to give the control of the water front to the State, and there is a State Board of Harbor Commissioners, immense port charges, a patronage distributed all over the "cow counties," etc., and it is the desire of all merchants that the city should control its own water front. The Committee on Public Improvements, in their report, decided that the harbor, wharves and docks and bridges should be in the charge of the Board of Public Works. The convention decided that there should be another commission to do that in the event of the State giving up control. An argument was made that such things were not public works. It was decided that the control of public utilities did not come under the head of public works and there will be other commissions to take charge of each utility acquired.

The committee thought the control of the parks should be in the hands of the Public Works Commissioners. The convention believes there should be a separate Park Commission, notwithstanding the fact that one of the committee making the report is at present acting as a Park Commissioner, and gave good reasons for his belief that the Board of Public Works should control the parks. The trend of the discussion at the meetings where this report was discussed was seemingly in the direction of a multiplication of boards and commissions and a dislike to have them in any way independent of the Supervisors. There also seemed to be a disinclination to prescribe any qualifications for the offices.

An impartial observer would have concluded from listening to the discussion that each man present felt that he might be a commissioner or member of a board some day and a qualification for holding the office would knock him out. Some, in fact, stated that they considered it an insult to the intelligence of the average man, who would be otherwise eligible, to prescribe that an engineer or any other professional man should fill a position. They thought the Mayor should not be hampered by such a foolish restriction. One might have thought also that some believed they would some day or other be elected a supervisor and would hate to lose control of the patronage of some departments.

San Francisco, Cal., Oct. 25, 1897. A. Z.

The Economy of the Proposed Deep Waterway from the Great Lakes to the Atlantic.

Sir: The report of Maj. T. W. Symons, U. S. Engineer, lately transmitted to Congress, is one of the greatest value; as it shows, after a most thorough investigation, what is the true method of improving waterways from the Lakes to the Atlantic.

His conclusions are as follows: A ship canal, suitable for the largest lake vessels from Lake Erie to New York, would cost not less than $200,000,000, and the yearly cost of maintenance would be $2,000,000.

The Erie Canal, as it is now being enlarged, will give commercial advantages equal to those of a ship canal. If the Erie Canal be enlarged so as to pass 1,500-ton barges on a continuously descending line from Lake Erie to the Hudson, it would enable freight to be transported at a lower rate than in large lake vessels passing through a ship canal. This is entirely independent of interest charges, while the barge canal could be built at one-quarter of the cost of the ship canal, so that three-quarters of the interest charges would be saved in addition.

The construction of a ship canal from the Great Lakes to the sea is not a project worthy of being undertaken by the General Government. The enlargement of the Erie Canal for 1,500-ton barges is a project worthy of being undertaken by the General Government.

An investigation made by me, the results of which were stated in a paper read before the Deep Water Ways Commission at Cleveland, and in a similar paper read before the American Society of Civil Engineers, both in 1895, led to exactly the same conclusions. Both of these papers were attacked by those who had ship canal on the brain, but my arguments were not refuted. It is very satisfactory to me that they have been confirmed by the independent investigations of so high an authority as Maj. Symons.

Thomas C. Clarke, M. Am. Soc. C. E.

44 Broadway, N. Y., Nov. 3, 1897.

Sir: The report of Major Thomas W. Symons, Corps of Engineers, on lake transportation, has just been printed, entitled "Preliminary Examination for the Ship Canal from the Great Lakes, etc., Document 86, H. R., 55th Congress, First Session," and it merits high praise for care in collating facts, skill in analyzing them and lucidity in presenting them.

On page 19 Major Symons states the elements of navigation between Buffalo and New York, via his Oswego Canal, as follows: Locks, 42, including one guard lock. Mileage, 483, including lake 132 miles, open river 163 miles, canalized river 94 miles, canal 94 miles.

On page 81 Major Symons gives an estimate of the cost of carrying freight between Buffalo and New York, via his Oswego Canal, in 5,000-ton ships, of 16-ft. draft, at 2.81 cts. per bushel, equal to 94 cts. per ton; and in 7,000-ton ships, of 20-ft. draft, at 2.28 cts. per bushel, equal to 76 cts. per ton.

In 1895 I published authentic figures of the cost of transportation in lake vessels, and stated cost of carrying freight between Chicago and New York, via Champlain route, as follows:

Vessels Carrying 4,990 Tons on 16-ft. Draft.

Full return cargoes, 1.72 cts. per bushel = 57.41 cts. per ton.
Half return cargoes, 2.175 cts. per bushel = 72.74 cts. per ton.
No return cargoes 2.655 cts. per bushel = 98.30 cts. per ton.

Vessels Carrying 7,000 Tons on 20-ft. Draft.

Full return cargoes, 1.334 cts. per bushel = 44.45 cts. per ton.
Half return cargoes, 1.645 cts. per bushel = 54.75 cts. per ton.
No return cargoes, 1.955 cts. per bushel = 62.285 cts. per ton.

My statements were based on actual performances on the Lakes. Major Symons' statement of the cost of operating steamers checks mine so closely as to make me think that he got his data from the same shipowner. Here are the figures:

Interest, Amortization and Repairs.

Symons ....$32,250 Dutton $34,000

Cost of Operating Steamer for Lake Season.

Symons ....$68,414.25 Dutton $70,750

With practically identical data as to the cost of operating ships, how does it happen that Major Symons thinks a ship canal valueless, while I think it would be a most valuable and profitable transportation route? The difference in our conclusions is due to this: Major Symons thinks the ship will be tied up in port three-quarters to seven-eighths of her time, and will earn money only one-eighth or one-quarter of her time; while I think that she will be earning money three-quarters of her time, and will be tied up only one-quarter of her time; or, even that she may be earning money seven-eighths and tied up one-eighth of her time.

The speed and time bases in my 1895 figures were that the ship would steam 13 miles per hour in lakes and rivers, 7 miles in canals, and lose one-half hour per lock.

Applying this basis to Major Symons' route, assuming the canalized river speed a mean between canal and open river speed, we have:

Time.		Hours.
On lake = ...132	÷ 13 =	10.16
On open river = ...163	÷ 13 =	12.54
On canalized river = . 94	÷ 10 =	9.40
On canal = ...94.3	÷ 7 =	13.50
In locks = ...42	× ½ =	21
Steaming time per trip.....66.6	= 2 days	18.6 hrs.
Steaming time per round trip .....= 5	"	13.2 "

Major Symons assumes that in a season of 220 days his steamer will make 10 round trips, consuming 22 days per trip, of which the total steaming time is 5 days, 13 hours; the total time wasted is 16 days, 11 hours; the time wasted being three-quarters of the whole time per trip.

His ship sails only between Buffalo and New York, the least profitable part of her possible trip; but the time is long enough for round trips between Chicago and Halifax or Havana.

He further assumes that the ship lies idle while lake navigation is suspended, making the yearly work of the ship as follows:

Total days in year	365
Total days steaming	55½
Total days idle	309½
Percentage of time idle	82

The ship which wastes 75 to 80 per cent. of her time has no use for a ship canal. What she wants is a sober captain.

The opponents of the ship canal resort to some strange assumptions. Two years ago they based their argument on the assumption that a ship would leave New York some time in November and get frozen up in Lake Superior until the next May, and that while doing business she would take 12⅞ days to unload at New York the cargo she loaded at Duluth in ¼ of a day. Major Symons makes the same assumption of the choice of winter quarters, and further assumes that it will take her 16 days to unload the cargo she loads in 3 to 11 hours. This style of argument might be carried further. It could be proved, for example, that if a vessel worked one day and tied up 40 days, the freight by her would cost more than it would by a mule cart, and that if she worked one day and tied up 364 days freight could be packed cheaper.

Yours truly, Chauncey N. Dutton.

(We submitted a proof of the above letter to Major Symons and append his reply as follows. —Ed.)

Sir: I have the honor to acknowledge receipt of your letter of Oct. 30 enclosing printed copy of Mr. Dutton's letter. I fully appreciate that my report on the ship canal question will receive much adverse criticism from those who have fully committed themselves to the project. It will hardly be possible for me to enter into controversy with everyone who may feel it his duty or pleasure to attack it.

I entered upon my investigation of the business side of the ship canal problem with a decided bias in favor of the canal, but as the facts and figures accumulated, I was compelled to the views stated in my report, that a ship canal from the Great Lakes to the ocean is not a project worthy of being undertaken by the United States Government. All the figures given in my report were derived from an infinite variety of sources, and my aim was to get at the exact truth as nearly as possible. These figures cannot be expected to coincide with those gathered and promulgated by a canal boomer with a patent lock to exploit, however meritorious the lock may be.

In his letter Mr. Dutton says:

In 1895 I published authentic figures of the cost of transportation in lake vessels, and stated the cost of carrying freight between Chicago and New York, via Champlain route, as follows:
Vessels carrying 4,990 tons on 16-ft. draft.
* * * * * * *
Vessels carrying 7,000 tons on 20-ft. draft.
* * * * * * *
My statements were based on actual performances.

I think Mr. Dutton should give us a little more detailed account of the "actual performances" of the 4,990 or 7,000 ton vessels carrying freight from Chicago to New York via the Champlain route. This is the first time I have heard of a 16 or 20-ft. vessel successfully traversing a 6-ft. canal. Mr. Dutton evidently does not mean what his language would imply.

Mr. Dutton further says: "Major Symon's statement of the cost of operating steamers checks mine so closely as to make me think he got them from the same shipowner." In this sentence Mr. Dutton practically admits that in this most important item he was satisfied with the statement of a single shipowner. It was very different with me; in this item, as in others, data was gathered from many sources, and Mr. Emile Low, M. Am. Soc. C. E., and myself spent much time in considering the data and fixing upon the figures which were finally adopted.

I believe that it was in the fertile brain of Mr. Dutton that the ship canal argument originated that vessels running on the lake and canal in summer could, during the ice-bound period of four or five months on the lakes, go to the seaboard and find profitable employment in ocean work. This argument ignores the fact that the economical types of lake vessels are not fitted, either in their construction, their arrangement, their machinery, or the knowledge and skill of their officers and crews for service on the ocean, and especially in the winter season, and the further fact that they would undoubtedly and always find the ocean field fully occupied by vessels engaged in it the whole year round.

It is on wholly impracticable arguments of this kind, and by ignoring the inevitable delays in port and in transit, the accidents to ships and to locks and to the water-ways themselves, and assuming speeds that cannot be realized, and a perfectly ideal condition of affairs, that Mr. Dutton is enabled to make his fine showing for a ship canal.

In this connection I beg that it will be understood that the figures of the cost of transportation given in my report are largely comparative, they being intended to show the relative value of different canals and systems, and all under mean, ordinary, every day conditions that would be most apt to exist, applied equally to all. It is easy to imagine that by a concurrence of favorable circumstances a ship might do much better than I have stated; but so, under equally as favorable circumstances, might a fleet of canal boats or larger barges. It is not fair to compare the minimum ideal cost of transportation by ship in a ship canal with a mean average of the cost by boats or barges in the Erie, or an enlarged, improved Erie Canal.

Mr. Dutton states that the steaming time between Buffalo and New York would be 2 days 18.6 hours. Of course, this time is predicated upon ideal conditions not likely to be realized. The speeds assumed by him are highly excessive. It is extremely doubtful if a higher rate than 4 miles per hour can be maintained on the canal and canalized river portions of the route mentioned, and it is not at all unlikely that this speed would be much less on the Niagara Ship Canal, this portion of the canal being principally through rock, requiring extreme care in navigating. Speed would also be slow on the short reaches between the locks.

Mr. Dutton makes no allowances for night navigation, for high winds which are frequent, or for fogs which are prevalent for many days of the season, and all of which would materially interfere with progress and cause delays. It would be necessary to slow up in meeting or passing other vessels, and if the canal were used to the extent to which alone would justify its construction, the aggregate delay from this cause would be very considerable.

That these causes of delays are not illusionary, it may be well to call attention to the difficulties in navigation experienced on the Manchester Ship Canal extracted from an article in Engineering News, under date of Feb. 15, 1894:

One vessel collided with the pierhead at Latchford locks and was damaged about her bows. This same ship, the "Venango," took 9 hours, 25 minutes, to make the 35½-mile trip up the canal (less than 4 miles per hour).

Almost every ship of any size so far passing through the canal has sustained some injury to her plates, or has inflicted damage to the canal banks. The soft sandstone rock forming the banks of the canal for some miles has been slipping under the influence of frost, and complaints are made of difficulties in navigation, caused by insufficient depth of water at some places, the lack of sufficient lights at night and the lack of sufficient headway under bridges.

On the proposed route from the Great Lakes to the [illegible]d, or any other, there will be many bridges, both railroad and highway, the passing of each one of which will cause more or less delay.

Another proof that the speeds assumed by Mr. Dutton are greatly excessive is instanced by the actual results obtained on the Suez Canal, where the average speed during a whole year for all vessels is but a little more than 4 miles per hour. It is a well-known fact that this canal is excavated through sand, a material which in case of grounding offers little danger to a vessel. And, again, it is only possible to obtain the speed mentioned by the widening and deepening of the canal prism, constantly in progress. Neither are there on this canal any locks necessitating a reduction of speed in approaching them.

On our near neighbor, the Welland Canal, with its comparatively small amount and character of shipping, delays due to accidents are common, frequently tying up the whole canal for days at a time.

In the latter part of his letter, Mr. Dutton imputes to me assumptions for which he has no authority. I have nowhere assumed Lake Superior as my choice for winter quarters for a freight vessel, although, as a matter of fact, I can see no good reason why it is not as good as New York or Lake Erie. The ship must be idle, anyhow, for several months, and it makes little difference where she spends them.

Nor has Mr. Dutton any right to state that I assume that it will take a ship 16 days to unload a cargo which she loads in 3 to 11 hours. This is an assumption based upon his own figures, and even then he totally ignores the time taken in securing and loading a return cargo.

Yours very respectfully,

Thomas W. Symons,

Buffalo, N.Y., Nov. 2, 1897. Major, Corps of Engineers.

Notes and Queries.

A correspondent wishes to know where the waterphone can be purchased. The device is used to detect leaks in service pipes or plumbing fixtures without entering

houses or other buildings. It is applied to the shut-off at night, when normally no water should be flowing. If water is running through the pipe the sound is transmitted through the rod of the waterphone to the receiving end, on which the observer's ear is placed. The instrument was put on the market several years ago by a firm in Cincinnati, which is not now in business. If any of our readers can supply second-hand instruments to our correspondent we shall be pleased to put them in communication with him.

G. D. V., Boston, Mass., asks who is right, A or B, in the following statement:

A cannon ball weighing 1,800 lbs. and having a velocity of 2,100 ft. per second at the mouth of the cannon from which it is fired, has an energy of 61,700 foot tons. A maintains that the 61,700 foot tons means 61,700 foot tons per second. B maintains that the 61,700 foot tons does not mean 61,700 foot tons per second.

B is right. Energy, or the capacity for performing work, is measured like work, in foot pounds or foot tons, and is independent of the time. The ball having an energy of 61,700 foot tons has the same work stored in it as that required to raise one ton 61,700 ft. high or 61,700 tons one foot high, whether such work is done in one second or in any other period of time.

WILL A SHIP CANAL FROM THE GREAT LAKES TO THE ATLANTIC PAY?

(With full-page plate.)

The River and Harbor Act of June 3, 1896, directed the Secretary of War:

to cause to be made accurate examinations and estimates of cost of construction of a ship canal by the most practicable route, wholly within the United States, from the Great Lakes to the navigable waters of the Hudson River of sufficient capacity to transport the tonnage of the lakes to the sea.

The amount of money available for the work, however, was so limited that the Department decided to make merely a preliminary examination, at a probable cost of $5,000, and assigned the work to Major Thos. W. Symons, Corps of Engineers, U. S. A., on Aug. 13, 1896. Major Symons' report was submitted June 23, and has just been printed and made public. The complete report forms a pamphlet of 110 pages, and contains so large an amount of valuable data on the problem that we strongly advise any of our readers interested in the subject to secure a copy of the complete report, which they can doubtless obtain from the Superintendent of Documents at Washington.

We present herewith as full extracts as our space permits of Major Symon's report, and have commented upon it in our editorial columns.

At the outset Major Symons says that the clause in the River and Harbor Bill above quoted may be interpreted in two ways: first, that by "tonnage of the lakes" is meant the largest vessels now running there, or which may reasonably be expected to run there in the near future; second, that the law might be interpreted to mean that the canal should have the location and size which will, at the least cost for construction and maintenance, enable the freight passing between the East and the West to be transported at the least cost. This latter is unquestionably the broader view of the subject. Major Symons continues as follows:

No matter what route is adopted for a ship canal, which shall give within American territory a continuous passageway for the great ships of the lakes to the sea, such a canal would be a stupendous work, one of the very largest ever undertaken by man, involving the expenditure of an enormous sum of money, roughly approximated at $200,000,000.

To justify the undertaking of such a stupendous work, it should be clearly shown, first, that it is a necessity and will accomplish the object aimed at—of greatly reducing the cost of transportation; second, that the benefits to be derived from it will be commensurate with its cost and the cost of its maintenance, and, third, that these or greater benefits are not practically attainable in some other way and at a less cost.

The practical question is, What can a great ship canal be reasonably expected to accomplish? It is not enough to answer this question by the statement that a ship canal will give free access for ocean vessels to the lakes, and lake vessels to the ocean or the seaboard, and that freight will thus be cheaper. All existing conditions of traffic and transportation, and the conditions which can be reasonably foreseen under all possible contingencies, must be considered. It must be clearly shown how the canal is to reduce freights not only to a lower point than those now existing, but to a lower point than those which can confidently be expected from other sources by the time the canal can be completed and that the reductions are fairly proportionate to the cost of building, maintaining, and operating the canal.

It would not be a creditable monument to the business management of American public works if the Government should expend $200,000,000 or thereabouts on a ship canal and then find, when it was completed, that it was very little used by the big ships for which it was intended and that the business on it was chiefly transacted in comparatively small vessels, which could be equally well accommodated in a canal of much less size and expense.

We must not fail to give consideration to the effect of such a canal upon the merchant marine of the country, nor should we confound real benefits with a mere transference of location of certain business enterprises and activities which benefit one section at the expense of another.

My study of the problem, in the light of existing conditions and of improvements in these conditions which are rapidly approaching completion, convinces me that the ship canal would not accomplish the object aimed at—of greatly lessening the cost of transportation—and that it is, therefore, not a necessity; that if built it would not be used to any great extent by large vessels, and that the benefits to be derived from it would not be commensurate with its cost and the cost of maintenance.

And furthermore, I am fully convinced that benefits fully equal in practical value to those which would be secured by the construction of a ship canal, at a cost approximating to $200,000,000, could be secured by the enlargement of the Erie Canal to a capacity sufficient for barges of about 1,500 tons net burden, the cost of which enlargement and improvement would, while great, be small in comparison with the cost of a great ship canal.

I therefore state that, in my opinion, the project of a ship canal from the Great Lakes to the navigable waters of the Hudson River, wholly within the United States and of sufficient capacity to permit the passage of the large vessels of the lakes, is not worthy of being undertaken by the United States, while it is my opinion that the realinement and enlargement of the Erie Canal to a size permitting passage to 1,500-ton barges and with capacity to transport the tonnage (the freight) of the lakes to the sea, is worthy of being undertaken by the United States, in the interest of the general commerce thereof, provided proper and satisfactory arrangements can be made with the State of New York.

The project of a great ship canal from the lakes to the Hudson or by any other route to the sea has been before the public for so many years; it has so many ardent, enthusiastic, and interested advocates; and the pictures which it presents of ships loading at Chicago, Duluth, and other lake ports, and thence proceeding on their uninterrupted way to New York, or to the ports of Europe, and of shipping from foreign and domestic seaports plying freely and directly to the lake ports without breaking cargo, are so alluring and delightful that I feel that I must give good reason for my belief that the project is unjustifiable and not worthy of being undertaken by the United States, except in the modified form mentioned and outlined herein.

Possible Routes for Ship Canals.

Broadly speaking, there are three possible routes for a ship canal from the Lakes to the Atlantic. These are the Erie Canal route, the Oswego route, which joins the Erie Canal route at Rome, N. Y., and the St. Lawrence and Lake Champlain route. These three routes have been so much discussed that no further explanation is needed for our readers. In discussing their relative merits, Major Symons condemns the St. Lawrence Champlain route in toto. If built at all, he believes that the portion of Canada in which it would lie should be ceded to the United States. It would be 244 miles longer, from Lake Erie to the Hudson, than the Oswego route, and this distance would mostly be in a contracted waterway. If built, he believes that it would turn export trade to the port of Montreal, and away from the port of New York. A still more important consideration is set forth as follows:

In selecting the route for a ship canal or an improved canal of smaller size, consideration must be given to the character of the commerce which it would serve, whether foreign bound, domestic, or both. In the general discussions which have been had of the ship canal problem, great stress has generally been laid upon its effect upon foreign-bound commerce and comparatively little upon its effect on domestic commerce. This is believed to be exactly the reverse of what should be the case, and domestic commerce should receive the first consideration, and foreign commerce the second.

An investigation has been made to determine the relative value of foreign and domestic Eastern markets to the producers of the West, and while the results are approximate and crude it indicates that the value of the Eastern domestic market is much greater than the value of the foreign market, and should receive the first consideration in the canal question.

Statistics show that during the year 1895 there were raised in the United States 90,640,545 tons of cereals, and there were exported 5,343,823 tons, leaving 85,296,722 tons to be used at home. That is, eighteen times as much of the cereal products of the country are used at home as are shipped abroad. During the same year, 1895, the cereal exports from the six North Atlantic ports, Montreal, Portland, Boston, New York, Philadelphia and Baltimore, were 3,868,254 tons. The receipts at these seaports during the same period amounted to 6,589,670 tons of cereals. This shows that of the cereal products annually reaching these exporting cities 58% is exported and 42% is consumed. As most of the Western products which are consumed in the thickly populated regions of New England, New York, Pennsylvania, New Jersey, etc., never reach the seaboard, but go directly to points of consumption, the vastly superior importance of the domestic over the foreign market is evident.

Regarding it from the standpoint of tonnage alone, it is certain that the domestic freight feature of a ship canal is of much more importance than the foreign freight feature. It is also to be considered that a canal which cheapens transportation only on foreign-bound produce benefits chiefly the producer, while a canal which cheapens transportation in domestic products and manufactures used at home benefits both producers and consumers, both the people of the East and the people of the West.

The considerations are mentioned to emphasize the great advantages of a canal by the Oswego or Erie Canal route, which would affect alike foreign and domestic commerce, over one by the St. Lawrence route, which would almost solely affect foreign commerce.

Comparing the Erie Canal and the Oswego routes Major Symons concludes that the latter would be the most advantageous for a large ship canal; but for a barge canal accommodating vessels of some 1,500 tons, the Erie route is much the superior, assuming, of course, that an arrangement could be entered into with the state of New York by which the present Erie Canal could be rebuilt and enlarged as proposed.

Size of Canal and Locks.

The size of canal and locks has an important bearing on the location and should be determined in advance of surveys.

The law of June 3, 1896, requires that the ship canal from the Great Lakes to the navigable waters of the Hudson River shall have sufficient capacity to transport the tonnage of the lakes to the sea. This may be interpreted as meaning that the ship canal shall be sufficient in size for the largest lake vessels.

The Government has entered upon a project for giving a channel of 20 ft. depth at mean stages through the upper lakes and their connecting waters. The work upon this project is now approaching completion, and it may be taken for granted that within a comparatively short time there will be a channel through the lakes capable of accommodating vessels of 18 ft. and a little over in draft at mean lake stages.

There is a strong and earnest movement among people interested in lake commerce looking to the deepening of the lakes or the regulating of lake levels by building dams to check the flow of water at the outlet of Lake Erie and in the narrow channel connecting the upper lakes. It is believed that this should be done, and that it will be done to the extent, at any rate, of preventing the waters of the lakes from falling below the mean level, with the result that the waters in all channels and lake harbors will be maintained in a deeper, much better, and more satisfactory condition than they are at present. It is also reasonable to believe that the future will see further work of excavation in the shallow interlake channels, and that the result of this and the regulation of the lake levels will be to give a navigable capacity throughout the lakes for vessels drawing 20 ft. To obtain this, however, will involve a very great expense on the part of the General Government and will take many years.

All the lake harbors have a navigable depth much less than this, the principal ones having 16 to 18 ft. To deepen all these lake harbors and arrange them to accommodate vessels drawing 20 ft. will require very large additional expenditures by the General Government, by cities, and by individuals. It is my opinion that 20 ft. draft may be considered the maximum draft to which vessels traversing the lakes and accommodated in their harbors will attain; at any rate, for a great many years. To exceed this and get capacity for vessels of 26 to 30 ft., as has been suggested, would involve expenditures for channels, harbors and their auxiliaries that would be enormous and unjustifiable and out of all proportion to the benefits to be derived therefrom.

Owing to the conditions on the lakes it is believed that the business of lake transportation can be done as economically with vessels of 20 ft. draft as with those of greater draft. In fact, lake vessels of 20 ft. draft equal in freight-carrying capacity the large ocean-going vessels suited to the North Atlantic trade of about 28 ft. draft.

The latest built large vessels of the lakes are now about 430 ft. long, 48 ft. beam, and have run during the last year with a maximum draft of 16 ft. 8 ins. During the season of 1896 the maximum loads carried were as follows: "Queen City," 5,796 tons corn; "Sir Wm. Siemens," 5,310 tons wheat; "Coralia," 5,600 tons iron ore; "W. D. Rees," 5,580 tons wheat and barley.

Vessels of the size of these named would, if loaded to 20 ft. draft, carry about 7,000 tons, and if lengthened to 500 ft. and widened to 50 ft., would, on a draft of 20 ft., carry about 9,000 tons or 300,000 bushels of wheat. If, therefore, a ship canal be made of sufficient capacity to accommodate vessels of 50 ft. beam and 20 ft. draft and a length of 500 ft., it is believed that it will fulfill the requirements of the law and will afford passage to any vessel that can be engaged in lake traffic for a great many years, if not forever.

If the canal be made larger than this, it should naturally be made of sufficient size for the accommodation of the large vessels engaged in ocean traffic. These large ocean vessels draw from 26 to 30 ft., and even more, and have breadths of 60 ft. and over, and a length of nearly 600 ft. It is stated by Colonel Gillespie, in a report on the subject, that the average draft of the outgoing loaded steamers from New York is now 27 ft., and that the draft of some of the larger ones has reached 30½ ft. on their outward passage. Based upon these facts, it is proposed to increase the depth of the New York harbor entrance to 35 ft. The new steamer "Pennsylvania," of the Hamburg-American line, on her recent trip, left New York with a mean draft of 31½ ft. If the harbors of the lakes and the interlake channels were of sufficient capacity for these ocean vessels, it would seem proper to seriously consider the advisability of constructing a ship canal suited to their size, if one is to be built. But these lake harbors and interlake channels are not, and probably never will be, of sufficient capacity for deep-ocean vessels, and, therefore, there is no practical use in considering such a canal suited to them. As stated elsewhere in this report, it is believed impossible for ocean vessels to do business economically on the lakes, or lake vessels to do business economically on the ocean, except in rare cases.

The difference between the cost of a ship canal, together with the accessories and betterments required for navigation by vessels of 20 ft. draft, and a ship canal with accessories and betterments in lake and river channels and harbors for vessels of 26 ft. draft would be extremely large. The latter would cost at least 50% more than the former. For vessels of 30 ft. draft, the cost of a canal and accompanying improvements would probably be double that of a canal and accompanying improvements for vessels of 20 ft. draft.

In the further consideration of this subject, therefore, the ship canal proposed will be for vessels not exceeding the following dimensions: Length, 500 ft.; breadth, 50 ft.; draft, 20 ft. The cost of a ship canal will be so great that it will only be justifiable to build it upon the supposition that it will be used by a large number of vessels. These vessels coming and going should be able to meet or pass freely anywhere en route with the minimum chances of collision with each other or with the banks.

On the other hand, any increase in the size of the canal beyond that absolutely necessary is obtained only at enormously increased expense. The size fixed upon for a canal is ordinarily a compromise between all the interests involved. After giving due consideration to all the interests involved, as far as I can see them, I would fix upon the following as about the proper size of the canal:

To enable the displaced water to flow with freedom under the vessels, to provide against the tendency of vessels to "squat," and to provide against a moderate amount of shoaling in the canal, and the drawing down and loss of water, it is believed that the normal depth should be 4 ft. more than the draft of the vessels navigating it, or 24 ft. The cross section of the water should be at least four times the immersed section of the largest vessels, or 4,000 sq. ft. With side slopes of 1 on 1½, this, with a depth of 24 ft., would require a bottom width of 138 ft.; a width at 20 ft. depth of 150 ft., and at the water surface of 210 ft. Such a waterway would have a cross section of 4,176 sq. ft.

The locks required for such a canal as that described, suitable for the passage of vessels 500 ft. long, 50 ft. broad and drawing 20 ft. of water, would have about the following dimensions:

	Feet.
Length in clear	530
Breadth	60
Depth on miter sills	22

If the ship canal have the traffic which alone can justify the expenditure necessary for its construction, these locks will have to be in constant operation in passing vessels of large size during the entire season of navigation. If the traffic through the canal attain to the dimensions indicated, it will undoubtedly be found necessary to duplicate the locks or to build other-sized companion locks, which altogether shall fulfill the demands of the business. If the traffic were confined to large vessels, such a series of locks as those suggested could, if everything worked perfectly and there were no detentions or accidents along the line, handle the suggested traffic of 24,000,000 tons per year. But perfection is impossible of attainment, and accidents and detentions are unavoidable, and much of the business of the canal would be done in small vessels, barges, canal boats, etc., so that the maximum tonnage which such a series of locks would pass would probably be from 12,000,000 to 15,000,000 tons yearly. During 1896 the average size of the freight loads on vessels passed through the Sault Ste. Marie locks was 872 tons and during 1895 was 839 tons. In laying out a ship canal, therefore, it would seem to be a prime necessity to provide lands for additional lock emplacements and to contemplate the large expenditures which will be required for the future construction of additional locks.

Another interpretation which might be put on the law of June 3, 1896, would be that the canal proposed from the Great Lakes to the navigable water of the Hudson should provide the means for transporting the tonnage (the freight) of the lakes between the lakes and the seaboard at the lowest possible cost, in vessels of the most economical type and size, and by the best available route which would admit of the construction and operation of the canal at the least expense.

Interpreting the law as above, and believing that my orders require me to consider the whole proposition from a business standpoint, I have considered the idea of providing for a barge navigation by way of the Erie Canal route, and my investigations convince me that this is by all odds the best business proposition for the Government to consider. A large lake or ocean vessel is not the type of craft that can be used most economically in a long and narrow waterway with many locks, such as any route between the lakes and the sea must necessarily be. A proper aggregation of smaller, lighter and cheaper vessels, will do the work on such a route cheaper than can the large vessels.

There is no question in my mind that any canal built by the United States between the East and the West should have its Eastern terminus at a great American commercial seaport, and the only such port available and worthy of consideration is New York city. There already exists a canal connecting the Hudson River with the lakes, which, as a long artificial waterway of small size, is in its importance without a peer in the world. I refer to the Erie Canal, which is 352 miles long between Buffalo and Albany.

This route is not available, and is not the best for a ship canal of large size, but I believe it to be the best available route for a large barge canal, and it is believed that the proposition to enlarge it into such a large barge canal should be seriously considered before the construction of a ship canal by another route is undertaken. My investigations have convinced me that such a canal navigated by barges will furnish a cheaper means of transportation between the East and West than would a ship canal navigated by large vessels, and its cost would be vastly less. I am fully convinced that if a ship canal is built, the great bulk of the business upon it will be done in towed barges and not in large lake or ocean vessels.

To enlarge the Erie Canal to a sufficient depth to accommodate barges of 1,500 tons capacity at fair canal rates of speed will require a cross section about as shown on the accompanying diagram. It is assumed that the barges will have a width of 30 ft. and a draft of 10 ft., and the canal must be large enough for the boats to meet and pass freely, and that a depth of 2 ft. of water under the boat is provided. Such a canal would have a cross section four times the immersed section of the boat, and allowing side slopes of 1 on 1½, would have the following size: Depth, 12 ft.; bottom width, 82 ft.; width at keel depth of 10 ft., 88 ft., and width at water surface, 118 ft.

There are considerable portions of the Erie Canal, which by simply deepening, would accommodate the barges and traffic mentioned, and as a general thing, the right of way for the Erie Canal, owned by the State of New York, would be sufficient for the suggested canal. The preferable route for such a canal would be to follow that outlined by State Engineer Elnathan Sweet, cutting out the Syracuse depression, canalizing the Mohawk River, and making a continuously descending canal all the way from Lake Erie to the Hudson. The barges used on such a canal could be constructed at a minimum cost, as they would be exposed to no open water on the lakes, and the whole route would be so situated that advantage could be taken of electrical towage, if this be ever developed into an economical system.

It is believed that a proper sized lock for this barge canal would be one with a depth of 12 ft. on miter sill, a width of 33 ft. and length of 420 ft. in the clear, with intermediate gates. This length would suffice for two barges, each 200 ft. long.

It is not to be understood that the size of barges and barge canal mentioned is to be considered as definitely fixed. It is simply taken as a type of about the size which would be most economical and advantageous. There are business reasons which would indicate that a smaller unit than a 1,500-ton barge would be preferable, and others that a still greater enlargement would be desirable. A careful balancing of all interests would be required to fix upon the most advantageous size. The size fixed upon in this report is to be regarded as a first approximation thereto.

Major Symons, in connection with this, presents a description of the Dutton pneumatic high lift lock which is now being built at Lockport, N. Y., and says:

If this lock is found in practice to be as successful as it appears to be in theory, there would probably be no reason why it should not be extended to locks of the larger size mentioned.

Seasons of Navigation.

Major Symons assumes the length a canal would be open as 224 days. This corresponds to the average open season on the present Erie Canal for 72 years.

Railroads.

The comparative value of rail and canal transportation to the shipper is discussed by Major Symons as follows:

Notwithstanding that a thorough water route now exists by which the products of the West can be taken to the East, and the further fact that these products can be and are taken at less cost by water than by rail, yet the railroads do by far the greater amount of business. This is due to many causes, among which the principal ones are that the railroads do their work more quickly; that they do it with regularity all the year round; to the fact that the railroads reach out far into the producing regions and secure the freight at its initial point, and to the fact that railroad freights in this country are really very low, intrinsically, and as compared with similar rates in other countries.

Another cause is the never ceasing, active, far-reaching business energy and combinations of the great army of railroad officials of the country, and still another and very potent cause is the lack of business organization of the Erie Canal traffic, for which there are no terminal facilities and no arrangements for through traffic. Another very important reason for the supremacy of the railroads in the business of transporting freight from the lakes eastward lies in the fact that a large proportion of the Western products going East never reach the seacoast, but are scattered by railroads from the lower lake ports to great numbers of places intermediate between the lakes and the sea, going to points in the mining and manufacturing regions of Pennsylvania and Ohio, and to the manufacturing and commercial regions of New England, New York, New Jersey, etc. These points nearly all have to be reached by rail, and it is, as a general rule, more economical to distribute this freight from the lower lake ports than it would be to take it through the canal to the seaboard and distribute it from there. Take, for instance, a cargo of 2,500 tons of flour. It is very rare that such a cargo is in one shipment, ordinarily it is in a hundred or thereabouts. It arrives in Buffalo and is divided up, and each shipment is loaded into its proper cars and forwarded to its predestined point of consumption. Nothing would be gained by taking the cargo through to New York, where terminal and handling charges are and always will be higher than in Buffalo and the other lower lake ports.

As indicated in detail in a table of freight rates, transfer charges, etc., which is herewith, the freight rates on a bushel of wheat from Chicago to New York, including transfer charges at Buffalo, for several years, are as follows. The rate on wheat is taken as a standard for purposes of comparison, all other freight rates being presumably proportioned thereto.

	Freight rates, Chicago to New York on wheat, cts. per bushel.					
Year.	'91.	'92.	'93.	'94.	'95.	'96.
All rail	15	14.23	14.70	12.88	10	12
Lake and rail	8.53	7.55	8.44	7	5.90	6.75
Lake and canal	6.83	6.48	7.18	5.31	4.98	6.32

During the entire year of 1895 there were received in New York 118,707,744 bushels of grain, flour and meal. Of this amount 103,119,330 bushels, or 86.8%, arrived by rail; 14,690,100 bushels, or 12.4%, arrived by canal, and 898,254 bushels, or 0.8%, arrived in coastwise vessels.

During the seven months of open canal and lake navigation in 1895 there were received in New York 84,241,715 bushels of grain, flour and meal. Of this amount there arrived by rail 69,880,629 bushels, or 82.9%; by canal 14,001,400 bushels, or 16.6%, and by coastwise vessels 349,686 bushels, or one-half of 1 per cent.

During 1895 there were shipped from Chicago to the eastward 153,629,551 bushels of grain, flour, and meal. Of this amount 88,127,966 bushels were shipped by lake and 65,501,585 bushels by rail. Of the amount going by lake destined to the Seaboard at least three-fourths was transshipped to cars at lower lake ports, and not more than one-fourth transshipped to canal boats.

These figures of amounts and rates are intended to indicate the apparent additional value of rail transportation over lake and canal transportation.

Experience shows that the great bulk of materials seeking water transportation are those of a coarse and cheap character, such as grain, flour, meal, lumber, coal, cement, salt, ore, pig iron, etc. If a ship canal were constructed from Lake Erie to reach the Hudson River, the products and materials which it might be reasonable to suppose would be transported through it would be mainly confined to these items, with possibly larger amounts of other products not now carried by water.

Possible Tonnage of a Ship Canal.

Major Symons makes a careful and extended discussion from all available data of the amount of tonnage which would seek a ship canal if one were built. He considers separately the products

shown in the table below and gives the estimates there shown.

We would call especial attention to the fact that these estimates are for the possible tonnage, not the probable tonnage. The statistics given by Major Symons show that only by the realization of the most sanguine and extravagant expectations could any such volume of traffic as that stated be reached, at least within a score of years after a ship canal could be completed. Those proposing to undertake such a canal as a business enterprise, therefore, will do well to estimate on a traffic one-third or one-fourth as great, or even less, during the first years of operation of such a canal.

Estimated Tonnage Possibly Tributary to a Ship Canal.

East-bound tonnage:	
Cereals and cereal products	8,000,000
Lumber	750,000
Iron ore	1,500,000
Pig and manufact'd iron, steel, steel rails, etc.	3,000,000
Bituminous coal	1,000,000
Copper and copper ore	100,000
Hog and beef products	1,000,000
Wool	100,000
Hides	100,000
Unclassified and miscellaneous freight, as fruits, oils, glass, glucose, glue, etc	2,450,000
Total	18,000,000
West-bound tonnage, including 2,000,000 tons of anthracite coal	6,000,000
Total	24,000,000

This amount of tonnage as tributary to a ship canal is not at present in sight. If it should be attained, it would be by the development of agriculture and its allied industries, and of manufactures, and by the diversion of business from railroads. It is predicated upon the assumption that the ship canal is built from the Great Lakes to New York by the shortest and best attainable route, which is believed to be either by the Erie Canal route or the Oswego route. If the canal should be constructed by way of the St. Lawrence to Montreal, with a Champlain branch to New York, no such amount of tonnage would be attained. Such a canal would be of benefit solely to such portions of the export trade as could be diverted to Montreal, a port open to navigation from the sea for only about six months of the year, and during a portion of which time navigation is rendered difficult and dangerous down the 980 miles of the St. Lawrence River and Gulf by fogs, snowstorms, floating ice, etc. No return freight of any consequence could be expected at Montreal, and in this the route would be sadly handicapped in comparison with a route starting from a great commercial center like New York.

The combined tonnage which could be considered tributary to such a St. Lawrence-Champlain Canal would not, in my judgment, exceed one-third to one-half of the tonnage tributary to a canal built by the Oswego route. If such a canal were in existence to-day I am satisfied that there would be a strong demand for a new canal by the Oswego-Oneida-Mohawk route, to cut out the 244 miles of extra distance to reach New York.

Ocean, Lake and Canal Vessels.

In considering the economic questions pertaining to a ship canal from the Great Lakes to the sea, one of the first facts brought to the attention of the investigator is that vessels which ply upon the ocean and those which ply upon the lakes are markedly different in their cost, construction and operation. So great are the differences that I am convinced that the two can not economically change places; that the highest and most profitable type of lake vessels cannot be used at sea, especially in the North Atlantic trade; that the ships fitted for use at sea cannot successfully compete in the freight business on the lakes with lake vessels, and that while it is possible from an engineering standpoint to build a vessel which shall combine to a limited extent the particular necessities and advantages of both lake and ocean vessels, such a vessel would not be a good business enterprise. However carefully a vessel may be designed for service on both lakes and ocean, she must necessarily be a compromise between two widely differing types, and inferior to each on its own waters. She can neither carry cargoes on the lakes as cheaply as the lake ships, nor on the ocean as cheaply as the ocean ships, and even supposing that the advantage of the avoidance of transfer will more than make up for these disadvantages and the time necessarily lost in any canal that can be constructed, she would have this advantage for but little more than half a year, and the remainder of the year she must run at a loss on salt water as compared with other ships.

I am convinced that if a ship canal were built so that vessels could pass from Lake Erie to the ocean, and it were found advantageous to use the canal by large vessels, that as a general thing these would be the large lake freighters, and their cargoes would be transferred at the seaboard, either directly or through the medium of elevators, lighters, storage docks, etc.

The pleasing picture of great ships loading with grain, flour and produce of all kinds at Chicago, Duluth, etc., and proceeding thence to transatlantic ports, and arriving at these lake ports with foreign cargoes, I can not believe will ever be realized to any great extent, even if a ship canal connecting the Great Lakes with tide water should be built.

The difference between the lake and ocean vessels for the carriage of freight may be illustrated by taking the latest models and highest development of each, describing and comparing them.

Ocean Freighter.—As a type of modern ocean freighter the Cunard Line steamer "Sylvania" is taken. The drawing herewith gives the longitudinal and cross sections and deck plans of this ship.

The dimensions of this steamer are as follows:

Length over all	feet..	473
Length of keel	" ..	460
Breadth	" ..	49
Depth	" ..	42½
Draft, fully loaded	" ..	27
Cargo capacity	tons weight..	7,500
Displacement, fully loaded	tons..	12,160
Free-board, fully loaded (from upper deck)	feet..	8½

The hull is built entirely of steel. She has five decks, as shown on the drawings; of these, the orlop, lower, main and upper decks are of steel. The shelter deck is partially plated and then sheathed with pine. The vessel is propelled by twin screws. There are nine water-tight bulkheads extending to the upper deck, and these are fitted with water-tight doors on each side of the 'tween decks only, to expedite the handling of cargo and cattle. Besides the double bottom which is fitted for water ballast, there are four large, deep tanks for trimming purposes—one aft and one forward, and one at each end of the engine and boiler space—these being additionally subdivided by fore and aft water-tight bulkheads. There are in all 24 compartments for water ballast, and part of the double bottom under the engines may be utilized for carrying reserve fresh water for cattle or boiler use. The bulkheads are so arranged that any two compartments, and in some cases three, may be flooded and still the vessel will keep afloat. The engines and boilers are in the center of the ship.

The vessel has capacity for 6,500 gross tons of dead freight and 420 cattle, for which latter accommodations are provided on the upper deck, as shown in the plan.

There are six holds—three forward and three aft of the engines—each provided with a hatch about 12 feet by 18 feet in size, and these are served by seven large steam winches, each having double derricks. The quarters for the officers are on the shelter deck forward of the engine space and about the engine hatch. There are four steel pole masts, fitted with fore and aft canvas for steadying purposes.

There are two twin sets of triple-expansion engines. It is estimated that such a ship as that described and illustrated, and fully suited for ocean work, would cost to build in this country about $500,000, or at the rate of $96 per ton of her extreme carrying capacity at 27 ft. draft.

Lake Freighter.—The latest type of steamer developed on the lakes for freight business is illustrated in the drawing herewith. It is the steamer "Geo. Stephenson," built by F. W. Wheeler & Co., for the Bessemer Steamship Co.

This steamer is constructed of steel, and its dimensions are as follows:

Length over all	feet..	428
Length of keel	" ..	408
Breadth	" ..	48
Depth	" ..	28
Dead weight	tons..	2,700
Cargo capacity:		
On 16-ft. draft	tons weight..	5,000
On 20-ft. draft	" " ..	7,000

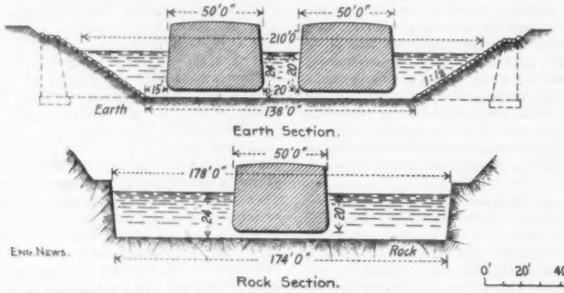
The ship is built in the simplest manner imaginable, and her lines are not fine. Main deck beams are provided, but there is no main deck laid except at the fore and after ends. The entire storage capacity of the ship is divided by five bulkheads into four great holds extending from the cellular water bottom to the shelter deck. The engines and boilers and coal bunkers are in the extreme after end of the vessel, the boilers being placed athwart ship with fire room between them. The crew are housed in the after deck house and in the forecastle. As the ship must frequently go west without cargo, a deep double bottom for water ballast is provided, which also adds additional security in the shallow channels connecting the various lakes where groundings are frequent. This double bottom, which is 5 ft. deep from collision bulkhead to engine bulkhead, is divided by center keelsons and solid floors into eight compartments built on the cellular system, with solid longitudinals extending from the bottom plating to the tank top, continuous fore and aft. The spar deck is of steel complete without wood covering, except inside the houses and on the forecastle deck. The hatch coverings are of wood.

Running only about seven months in the year with a speed, loaded, of about 12 miles per hour in the open water, everything in the design of this ship is subordinated to the rapid handling of cargo in port. For instance, it is usual to put 5,000 tons of iron ore or coal into the ship in three or four hours and take it out in fifteen hours; and grain elevators will load such a ship in two or three hours, and will, under favorable circumstances, take out her load of 5,000 tons, or 167,000 bushels of wheat, weigh it, and store it in ten or twelve hours. This rapid handling of freight is rendered possible by the dock facilities of the lake ports, and by the extraordinary hatch development of the ship. Each of her four holds has three great hatchways, making twelve in all. These are spaced 24 ft. apart between centers, and in size are 8 ft. in a fore-and-aft direction and 32½ ft. abeam in the clear.

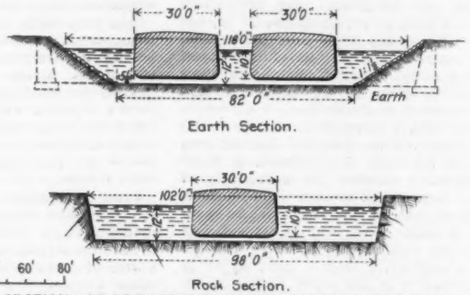
As the power is small, the voyage short, and fuel can be obtained at intermediate points if necessary as well as at terminals, the coal bunkers are small and so arranged that coal can be spouted in from high pockets or loaded from floating fuel scows carrying derricks, while the cargo is being unloaded. The engines are jet condensing, surface condensation not being required on the fresh water of the lakes, and never being far from repair shops, few tools or spare parts are carried. The engines are triple expansion, the cylinders being 25, 41 and 66 ins. in diameter, by 42 ins. stroke. The cost of such a ship, fully equipped, is about $250,000, or at the rate of $50 per ton of carrying capacity at 16 ft. draft, or $35.71 per ton at 20 ft. draft.

In many instances, and especially for the vessels engaged in the ore business, a steam freighter has a consort, a motorless barge similarly constructed and about the same freight capacity as the steamer herself, and is towed by the latter. These consorts have a much smaller crew and accommodations therefor than the steamer, and about the only machinery on them is the towing apparatus. The quiet open water of the lakes renders this system of towing practicable. It is not believed that any such system could be safely conducted on the foreign trade on the North Atlantic, although in the transportation of coal from one domestic seaport to other domestic ports, the barge navigation, with barges of moderate size, has assumed very large proportions.

Lake Whaleback Freighter.—The American Steam Barge



SECTIONS OF PROPOSED LAKE ONTARIO & HUDSON RIVER SHIP CANAL FOR VESSELS OF 20-FT. DRAFT AND 9,000 TONS CAPACITY.



SECTIONS OF PROPOSED BARGE CANAL ON ERIE CANAL ROUTE FOR VESSELS OF 10-FT. DRAFT AND 1,500 TONS CAPACITY.

Co. have a large fleet of steamers and barges on the lakes of the whaleback type. The fleet consists of nine steamers, varying in size from the "J. L. Colby," 264 ft. length, 36 ft. beam and 22 ft. depth, to the "Frank Rockefeller," one of the latest built. This vessel on a 14½-ft. draft carries 3,889 tons of freight, and on a 16-ft. draft, 4,576 tons. The ship has a water bottom about 4 ft. deep. The hold is divided into three portions by bulkheads. The engines and boilers and officers' quarters are in the extreme after part of the vessel and the quarters for the crew in the forecastle. There are 11 main cargo hatches, each 8 ft. by 12 ft., situated on the center line of the vessel, and 13 smaller trimming hatches, each 4 ft. by 6 ft., situated nearer the side.

The cost of such a vessel is about $210,000, or at the rate of $43.70 per ton of carrying capacity.

The illustrations and descriptions indicate the main difference between the ocean and lake freight vessels of the most recent type. These main differences may be summarized as follows:

Ocean vessels fitted for combating the storms of the North Atlantic are built much heavier, stronger, deeper, and on finer lines than are the lake ships. The machinery differs radically, owing to the salt water, and is more expensive and differently placed. In the ocean ships surface condensers are imperative, and much brass or lead piping is required. The machinery, placed amidships, interferes with rapid loading and unloading. The hatches are too small and too few, and not properly spaced to suit docks, elevators, etc., and the rapid handling of freight in lake ports. The coal bunkers are too large, occupying valuable room. All deck constructions, the rudder, anchors, chains, etc., are heavier and more expensive than are required for the lakes. The decks add weight and interfere with loading, storing, and unloading bulky, coarse freight. Speaking comparatively, the bottoms of ocean vessels are made for floating and the bottoms of lake vessels are designed for grounding.

The ocean vessels carry hoisting engines and derricks for handling cargo, which on the lake vessels are unnecessary, as all lake docks are fitted with machinery for that purpose. Making long voyages, the ocean vessel has to carry many spare parts and tools for repairs, and skilled men to use them. A greater number of men are employed on ocean vessels than on lake vessels of the same class, and the officers of the ship must be practical sea navigators. For the same capacity, ocean ships ordinarily draw much more water than do lake vessels, and the cost per ton of carrying capacity is greater. Ocean vessels in very many instances combine a freight and passenger business, which lake vessels rarely do.

There is a vast amount of business done on the lakes in vessels which are much smaller and of different type from those described and illustrated herein. Many steamers designed for general business of package and bulk freighters have a main deck laid and have four to six large ports on each side of the ship into the 'tween decks, through which freight is trucked, and hoisting machinery is provided for serving the holds. These steamers are all smaller, and most of them much smaller, than the coarse freight boats.

The rapid change in recent years in the type and size of lake vessels is an important element in determining the rate of deterioration in the value of vessel property. Many vessels which five years ago were in the front rank have had their value reduced to fully one-half owing to the evolution of lake craft.

There are no lake vessels engaged exclusively in the grain-carrying business. During the spring and fall, just after the opening and before the closing of navigation, many ships come to Buffalo with full loads of grain and business is very active. During the midsummer season the grain business dies down and vessels have to seek other commodities to carry, and the season is one of comparative dullness.

Although, as previously stated, it is not believed that ocean vessels would to any great extent run through a canal to the lakes, or that lake vessels would run to distant seaports, yet the fact that they could do so would undoubtedly lead to a minimizing of transfer and port charges in New York and at lake ports. Practically the same thing would result from the inauguration of a system of large barge navigation with barges of about 1,500 tons capacity suited to traverse the lakes and to go, if necessary, to ocean coastwise domestic points.

One of the benefits claimed for a ship canal by some of its advocates is that it would enable lake ships to go to sea and engage in the transportation business at sea during the closed winter period on the lakes. This is doubly impracticable from the fact that the lake vessels are not fitted for service at sea either in hull or machinery, and would be particularly deficient in winter when the North Atlantic requires craft of the staunchest character, and also from the fact that the business field which they could enter would be fully occupied by vessels engaged in it all the year round.

Canal Vessels.—Vessels designed to carry freight on narrow and contracted waterways like canals and rivers can be built in a much cheaper manner than is required for vessels designed to navigate the ocean or Great Lakes. For the same reason that ocean vessels have to be built heavier and stronger than lake vessels, so lake vessels have to be built heavier and stronger than would boats designed exclusively to navigate canals and rivers between the Great Lakes and tide water.

As the cost of the carrier, by the interest which it represents and the deterioration which the vessel undergoes, is a continual and never ceasing item of expense, it must be given great consideration in estimating the cost of transportation.

The present type of Erie Canal boats carries on 6-ft. draft 240 to 246 tons, and costs about $3,000 each, or at the rate of $12.19 per ton of carrying capacity. Many of them are capable of being loaded to 8 ft. draft. The boats which will navigate the improved Erie Canal will carry about 400 to 410 tons, and it is estimated will cost about $3,500 each, or at the rate of $8.75 per ton of carrying capacity. If these boats are united into fleets of four boats, including one steamer, the cost per ton of carrying capacity of the fleets would be for the present Erie Canal about $19.40, and for the improved Erie Canal $13.67. If six-boat fleets are used, the cost per ton of carrying capacity would be for the present Erie Canal $17.39, and for the improved Erie Canal $12.04.

For large 1,500-ton barges, suitable for use on a still further improved Erie Canal, the value per ton of carrying capacity for the plain barges would be about $8, and for a fleet of three plain and one steam barge about $10.70. If the plain barges be run in connection with semi-independent steamers, as outlined hereinafter, the value per ton of carrying capacity, including steamer, would be about $10.14.

As illustrations of the very low cost of carrying capacity on narrow waterways, attention is invited to the open coal boats and barges in use on the Ohio and Mississippi rivers. Coal boats are great rectangular boxes, 170 ft. long, 26 ft. wide, and 9½ to 10 ft. deep. They are loaded to 8 ft. draft, and carry 1,000 gross tons of coal. They cost about $500, or at the rate of 50 cts. per ton of carrying capacity. Tows of 30 to 40 of these loaded boats, carrying 30,000 to 40,000 tons of coal, are taken down the Mississippi by one towboat. On the lower river coal boats are sold with the coal for the lumber that they contain.

Coal barges are made more substantial than coal boats, and are towed back and forth, chiefly in the Pittsburg-Cincinnati-Louisville-St. Louis trade. The standard dimensions of a coal barge are: Length, 130 ft.; width, 25 ft.; depth of gunwales, 7½ ft. Their sides are made of 6-in. pine and bottoms of 4-in. oak. They are loaded to draw 6 to 6½ ft. and their capacity averages 500 tons. They cost $1,000 to $1,100, or at the rate of $2 to $2.20 per ton of carrying capacity. Coal is taken from Pittsburg to New Orleans, 1,970 miles, at an average cost of 71 cts. per ton. The phenomenally low cost of this coal transportation is due to wisely adopting for the work a carrying plant of minimum cost, suited to the waterway on which it is to run, and the lesson which the illustration is intended to convey is that economy requires the vessel to be suited as well to the waterway as to the materials carried.

The following is a summary of the estimated round value per ton of carrying capacity of vessels and fleets of vessels mentioned herein:

Steel ocean steamers	$60.00 to $70.00
Steel lake steamers	35.00 " 50.00
Erie Canal boats, plain	9.00 " 12.00
Erie Canal boats, in fleets with steamer	12.00 " 20.00
Large 1,500 ton canal barges:	
Plain, about	8.00
In fleets, with steamer	10.00 " 11.00
Ohio and Mississippi coal boats	.50
Ohio and Mississippi coal barges	2.00 " 2.20

Loading and Unloading Vessels.

The report presents a very large amount of information as to the cost of transferring bulk freights, coal, ore, grain, etc., and also package freights at the Lake ports and also at New York, by the most modern methods and appliances. Space forbids our presenting or even attempting to summarize this, and we pass at once to Major Symons' discussion of the general military and commercial aspects of the enterprise.

Military Aspect.

I am unable to believe that such a ship canal is needed for the military advantages which it would confer. It would only be of use in the event of a war with Great Britain for the passage of our war ships from the sea to the Great Lakes. In the event of such a war, it is inconceivable that any of our war ships would be allowed to leave the seacoast for service on the lakes. All that we have, and many more in fact, would be needed for the protection of our seaports and for aggressive operations against the navy and commerce of Great Britain on the high seas. If proper and comparatively inexpensive precautions are taken, the Great Lakes will, in the event of such a war, need no naval assistance from the seacoast. An English naval force could only reach the Great Lakes by way of the St. Lawrence River and its canals, which latter limit the size of the vessels to those of a small class. These St. Lawrence canals lie along and near our border and within easy reach, and in some cases they can be enfiladed, and even taken in reverse, from good artillery positions on our side of the river. The difficulties of a hostile movement up the river to Lake Ontario would be very great if opposed with vigor, and might easily be rendered impossible by the destruction of some of the canals. Arrived in Lake Ontario, such a hostile force would have to pass the Welland Canal, a canal also within easy reach of our borders and subject to being assailed and destroyed by a land force or an improvised naval force on Lake Erie. Upon the upper lakes—Erie, Huron, Michigan and Superior—the United States has a vast merchant marine, eight times greater in tonnage than the merchant marine of Canada, and vastly excelling in individual ships. If the Government, as has been suggested and recommended, would provide at the different lake ports stores of arms and war munitions suitable for arming our best lake vessels, and arrange for taking possession of and arming and manning these vessels quickly and effectively, an American naval force could be improvised upon

TABLE I.—Average Freight Charges from Chicago to New York on a Bushel of Wheat—1874 to 1896.

Year.	By lake and canal, including transfer charges at Buffalo.	By lake and rail, including transfer charges at Buffalo.	By all rail.	Lake freights.			Canal freights.						Elevating and storage at New York, receiving, weighing, and discharging.
				Total freight rate, Chicago to Buffalo, including shoveling at Buffalo.	Shoveling charge at Buffalo.	Net freight rate, by lake, Chicago to Buffalo.	Elevating and storage at Buffalo, receiving, weighing, and discharging.	Canal, Buffalo to New York, including tolls and trimming at Buffalo and shoveling at New York.	Canal tolls.	Trimming charge at Buffalo.	Shoveling charge at New York.	Net rate for canal transportation.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1874	15.39	16.9	28.7	4.03	0.40	3.63	1.25	10.11½	3.10	0.10	(a)	(a)	(a)
1875	12.43	14.6	24.1	3.42	0.40	3.02	1.05	8.01	2.07	0.10	(a)	(a)	(a)
1876	10.58	11.8	16.5	2.90	0.35	2.55	1.00	6.68	2.07	0.10	(a)	(a)	(a)
1877	12.24	15.8	29.3	3.72	0.32	3.40	1.00	7.52	1.03	0.10	(a)	(a)	(a)
1878	10.15	11.4	17.7	3.07	0.32	2.75	1.00	6.08	1.03	0.10	(a)	(a)	(a)
1879	12.60	13.3	17 3	4.74	0.37	4.37	1.00	6.86	1.03	0.10	(a)	(a)	(a)
1880	13.27	15.7	19.9	5.76	0.40	5.36	1.00	6.51	1.03	0.11	(a)	(a)	(a)
1881	9.065	10.4	14.4	3.44	0.42	3.02	0.875	4.75	1.03	0.125	(a)	(a)	(a)
1882	8.765	10.9	14.6	2.50	0.42	2.08	0.875	5.39	1.03	0.125	(a)	(a)	(a)
1883	9.245	11.5	16.5	3.41	0.37	3.04	0.875	4.96	(b)	0.125	(a)	(a)	(a)
1884	7.185	9.55	13.12	2.18	0.38	1.80	0.875	4.13	(b)	0.125	(a)	(a)	(a)
1885	6.745	9.02	14.00	2.02	0.37	1.65	0.875	3.85	(b)	0.125	(a)	(a)	(a)
1886	9.585	12.00	16.50	3.68	0.37	3.31	0.875	5.03	(b)	0.125	(a)	(a)	(a)
1887	9.385	12.00	15.74	4.13	0.40	3.73	0.875	4.38	(b)	0.125	(a)	(a)	(a)
1888	6.805	11.00	14.50	2.50	0.40	2.10	0.875	3.37	(b)	0.125	0.15	3.095	0.625
1889	7.765	8.70	15.00	2.51	0.40	2.11	0.875	4.38	(b)	0.125	0.15	4.105	0.625
1890	6.725	8.50	14.31	1.96	0.40	1.56	0.875	3.89	(b)	0.125	0.15	3.615	0.625
1891	6.835	8.53	15.00	2.38	0.40	1.98	0.875	3.58	(b)	0.125	0.15	3.305	0.625
1892	6.485	7.55	14.23	2.19	0.40	1.79	0.875	3.42	(b)	0.125	0.15	3.145	0.625
1893	7.185	8.44	14.70	1.66	0.40	1.26	0.875	4.65	(b)	0.125	0.15	4.375	0.625
1894	5.315	7.00	12.88	1.27	0.40	0.87	0.875	3.17	(b)	0.125	0.15	2.895	0.625
1895	4.985	c5.90	c10.00	1.92	0.35	1.57	0.875	2.19	(b)	0.075	0.15	1.965	0.625
1896	6.325	6.75	12.00	1.70	0.35	1.35	0.875	3.75	(b)	0.075	0.15	3.525	0.625
Average for last five years	6.059	7 128	12.762	1.743	0.38	1.368	0.875	3.436	.....	0.105	0.15	3.181	0.625

a Data uncertain.
b Tolls abolished.
c Actual average rate. Officially published tariffs higher, and which were cut to discredit canal.

these lakes which would greatly preponderate over any which could be improvised against it or brought to oppose it.

The money expense to which the American Government need go to provide these arms and munitions and place the upper lakes in a satisfactory condition of defense would be insignificant in comparison with the cost of a ship canal; the cost of one or two locks would be sufficient.

A ship canal must, therefore, be justified, if at all, by the commercial advantages which it will give above the present means of transport, or other and less costly means which may be supplied in the future.

Commercial Aspects.

To build a ship canal from the Great Lakes to the ocean by any of the possible routes herein mentioned entirely within the United States to accommodate vessels 500 ft. long, 50 ft. broad, and 20 ft. draft would, at a rough estimate, cost $200,000,000. To maintain such a canal, keep it and all its structures in repair, operate locks, bridges, etc., maintain river channels, reservoirs, feeders, etc., would cost, at a rough estimate, $2,000,000 per year.

The amount of traffic which can reasonably be considered as tributary to a ship canal is, as stated in another portion of this report, about 24,000,000 tons annually. To justify the ship canal from a business standpoint, the saving on the transportation of this tonnage over the cost of its transportation by existing means and methods, or those which may reasonably be expected to exist, must at least equal the interest on the cost of the canal plus the annual cost of maintenance and operation.

Assuming an interest charge of 3%, this would amount to $8,000,000, which may be said to represent the annual cost of a ship canal from the Great Lakes to the navigable waters of the Hudson River. This requires a saving of 33⅓ cts. on each ton of freight, or if wheat is considered, a saving of 1 ct. per bushel.

Will a ship canal effect this saving over the cost of transportation by all rail and by the present lake and canal routes from the upper lake ports to New York, including cost of transfer at Buffalo? Will it effect it over the cost of transportation, including transfer, when the improvements now under way on the Erie Canal are completed? Will it effect the required saving over the cost of transportation by an enlarged Erie Canal, which will permit the use of barges of a similar capacity to the barges now so extensively used in the coastwise coal trade?

To answer all these questions intelligently requires a comparative study of the cost of transportation by rail and lake, and by canal, and from the facts secured to determine the probable cost of transportation by such canal and by the Erie Canal as it is now being improved and as it may be further improved. Grain and grain products will continue to furnish the chief item of freight between the lakes and the sea, and so the comparative study will be made on the basis of a bushel of wheat. The accompanying table (Table I.) of freight rates and transfer charges has been prepared with much care.

In commenting on this table, Major Symons points out that the excessive cost of transferring grain at Buffalo is one of the main arguments of the ship canal advocates. But to engage in an expenditure of some $200,000,000 for the sake of breaking up the combination of elevator owners at Buffalo, would be manifestly absurd. Natural competitive forces now at work, are likely soon to bring down these charges to a reasonable figure.

In considering the problems presented, Major Symons was led to make a study of the system of coastwise coal transportation in barges which has attained such large proportions in the past 15 years. Previous to 1880 almost all the coal transportation along the coast was by sailing vessels. At present more than 90% of all the coal shipped along the coast, amounting to 25,000,000 to 30,000,000 tons per annum, is carried by barges, and the coal is transported at a cost not more than one-third as great as the cost 15 years ago. Major Symons continues as follows:

The development of this coastwise barge transportation business has been gradual, and it has now acquired such a definite standing as the most economical system available, and has assumed such enormous proportions that I have deemed it proper to call attention to it as an alternative to a ship canal, and to the advisability of providing for such a traffic between the Great Lakes and the sea by an enlargement of the Erie Canal, so that fleets of barges of the most popular capacity engaged in the coastwise business can pass through. Such an improvement could be made at a cost small in comparison to the cost of a ship canal from the Great Lakes to tide water sufficiently large to accommodate ocean or lake vessels, and it would, in my opinion, be the best business proposition which could be adopted for giving cheap transportation between the lakes and the Seaboard, benefiting alike the people of the East and of the West, and keeping the transportation business in the hands of Americans.

This improvement would consist in the enlargement of the Erie Canal to permit the passage, at fair canal rates of speed, of fleets of barges each 200 ft. long, 30 ft. broad, and 10 ft. draft, each carrying 1,500 tons of dead freight, with locks arranged for the passage of two such boats at one lockage.

In transacting the business of freight transportation between the lakes and the sea, the advantages of the division of the carrying capacity into a number of smaller units capable of splitting up at terminal ports and going to different ships and docks and its separation from the power plant, over the single united power plant and freight carrier, as represented by the present lake freight steamer, would be nearly as great and marked as it is in the transaction of the freight business between coastwise points already mentioned.

Barges of the size mentioned could be made with the

In making the accompanying comparison of the cost of transportation, the element of lake navigation is eliminated, and the wheat, which is assumed as the standard freight, is supposed to be brought to Buffalo for shipment on to New York; first, in the lake freighter in which it came; or second, by the present Erie Canal; or third, by the Erie Canal as it will be when the pending improvements are completed, using in both cases fleets of canal boats consisting of a steamer and three to five ordinary canal boats; or fourth, by the Erie Canal enlarged to accommodate 1,500-ton barges, a fleet consisting of one steam barge and three motorless barges with the business conducted as at present; or fifth, conducted upon the same general business principles which govern the coastwise coal transportation business.

A study of Table II. indicates that, with the transfer charges as they are at present, the improved Erie Canal will have an advantage over the 5,000-ton ship in the ship canal of 4 cts. per ton for four-boat fleets and 8 cts. per ton for six-boat fleets, or $860,000 to $1,920,000 per year; while the 7,000-ton ship will have an advantage over the improved Erie Canal navigated by four-boat fleets of 14 cts. per ton, and over the same canal navigated by six-boat fleets of 10 cts. per ton, or from $2,400,000 to $3,360,000, respectively.

As the business of transportation through the canal would by no means all be done in vessels of the largest capacity, it is believed that the ship canal would have no advantage in furnishing cheap transportation over the improved Erie Canal with the transfer rates as at present, while with the reduction of transfer rates to three-fourths of a cent per bushel, the advantages would be decidedly with the smaller canal.

Comparing the ship canal with the Erie Canal radically improved to accommodate 1,500-ton barges, we see an advantage of the barge canal with the business conducted in fleets as at present over the 5,000-ton ship of 25 cts. per ton, or $6,000,000 per annum, and over the 7,000-ton ship of 7 cts. per ton, or $1,680,000 per annum, a mean advantage of $3,840,000 with the Buffalo transfer charges remaining as at present.

Still further considering this barge canal, if we assume the partial separation and independence of motive power and carrying capacity and the transaction of business with the practically as it is done by the coastwise coal barge companies, the advantages of the barge canal over the ship canal appear in still greater relief.

With the transfer charges reduced to three-fourths of a cent per bushel, the advantages of the barge canal over the 5,000-ton ship would be 41 cents per ton, or $3,840,000 per year, and over the 7,000-ton ship would be 23 cents per ton, or $5,520,000 per year, and advantage over the ship of mean size of $7,680,000 per year.

As a barge canal of the size proposed would accommodate barges of a size sufficient to go anywhere on the lakes with safety, it is assumed that it would be able to force down transfer charges at any point to a minimum, and the last-named figures, therefore, represent approximately the advantages to the shipper of the barge canal over the ship canal.

As the barge canal, by the enlargement of the Erie Canal, can be constructed at a cost probably not exceeding one-fourth of the cost of a great ship canal, its double advantages in regard to first cost and economy in usage are very great. So great appear the advantages of barge navigation in a long canal over navigation by large vessels that I am convinced that were the ship canal built it would be little used by large vessels, and the bulk of the business would be done by barge lines, which could be accommodated almost equally well in a canal of much smaller size and of far less cost. I am, therefore, convinced that a ship canal from the Great Lakes to the Hudson is not a project worthy of being undertaken by the United States.

TABLE II.—Estimated Cost of Carrying Wheat from Buffalo to New York by Various Proposed Waterways and Vessels of Various Types.

	Estimated cost by ship canal.		Estimated cost with wheat transferred at Buffalo at cost of ⅝ cents per bushel, and up freight transferred at cost of 25 cents per ton.		Estimated cost if transfer charges at Buffalo were reduced to ¾ of a cent per bushel, and up freight at 25 cents per ton		Estimated cost of transportation with all transfer charges eliminated.		Estimated cost of transportation, with trimming charges at Buffalo and shoveling charges at New York added		Estimated cost, Chicago to New York, including lake rate at 1.37 cents per bushel, transfer charges at 1.30 cents per bushel, and 10 per cent profit on cost of transportation between Buffalo and New York.		Estimated cost, Chicago to New York, including lake rate at 1.37 cents per bushel, transfer charges at ¾ of a cent per bushel, and 10 per cent profit on cost of transportation between Buffalo and New York.	
	Per bushel.	Per ton.	Per bushel.	Per ton.	Per bushel.	Per ton.	Per bushel.	Per ton.	Per bushel.	Per ton.	Per bushel.	Per ton.	Per bushel.	Per ton.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
By ship canal:	*Cents.*	*Cents.*	*Cents.*		*Cents.*		*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*		*Cents*	
In 5,000-ton vessels	2.81	94	.....	.....	.....	.....	.....	.....	.....	.....	4.46	$1.49	4.46	$1.49
In 7,000-ton vessels	2.28	76	.....	.....	.....	.....	.....	.....	.....	.....	3.88	1.29	3.88	1.29
By Erie Canal in its present condition:														
With four-boat fleets	.....	.....	3.81	$1.27	3.42	$1.14	2.66	89	2.88	96	5.60	1.87	5.05	1.68
With six-boat fleets	.....	.....	3.56	1.17	3.11	1.04	2.41	80	2.63	88	5.32	1.77	4.77	1.59
Erie Canal as it is being improved:														
With four-boat fleets	.....	.....	2.70	.90	2.29	.76	1.54	51	1.76	59	4.36	1.45	3.81	1.27
With six-boat fleets	.....	.....	2.57	.86	2.16	.72	1.41	47	1.63	54	4.22	1.41	3.67	1.22
1,500-ton barge canal:														
Business conducted with four-boat fleets as at present	.....	.....	2.07	.69	1.66	55	91	30	1.13	38	3.67	1.22	3.12	1.04
With semiindependent motive power and consorts	.....	.....	2.01	67	1.60	.53	85	28	1.07	36	3.60	1.20	3.05	1.02